Reclaiming Urban Streets for Walking in a Hot and Humid Region: The Case of Dammam City

The Kingdom of Saudi Arabia

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In The Name Of Allah
The Most Gracious
The Most Merciful

Author’s declaration

I declare that the research work contained in this thesis and the information it describes, unless otherwise appropriately stated and referenced within the text, is my own and has been composed solely by myself. No part of this thesis incorporates any material has been submitted for any other degree, university or professional qualification.

Montasir Masoud Alabdulla

Abstract

Due to the current practices of street design in countries with hot and humid climates that prioritise air-conditioned cars as the favoured mode of transport, the physical and spatial characteristics of the street space have failed to retain much or any user-friendliness for walking or for sustaining street life. Moreover, particularly in Saudi Arabia, the increasingly sedentary lifestyle is leading to significant health problems and prevalence of lifestyle diseases. However, there has been limited research conducted on the use of urban streets under hot and humid conditions, and even less is known about the impact of certain socio-cultural aspects in, for example, Muslim countries, on the design of streets for walking. Such a situation poses challenges to the urban space researcher and designer interested in gaining a better understanding of how walking can be restored into the street space. This thesis contributes to the advancement of knowledge in this area by integrating three influential factors connected to walking in a single study; an approach which has not been elaborated previously.

This thesis aimed to broaden the understanding of pedestrians' requirements, attitudes and preferences in order to identify ways in which the neglected street space can be reclaimed for walking under hot-humid climatic conditions and to inform decision-making into improved street design. The scope of this research centred on combining an understanding of pedestrians' thermal comfort in a hot and humid urban environment, that of the city of Dammam in Saudi Arabia, where the problem is particularly acute, coupled with exploration into the socio-cultural aspects through which behaviour such as undertaking increased physical activity is governed. The research postulated an interactive relationship between the existing conditions of the street space and these two factors.

Owing to the multifaceted nature of the factors affecting an individual's choice to walk, there are few accepted theoretical frameworks, hence studying the cause-and-effect relationship between street design and walking is challenging. Following the literature review and analysis of existing street characteristics; the strategy of mixed-method data collection combining participant observation with interviews and a questionnaire was conducted.

The findings revealed the dual impact of key street characteristics on pedestrians' reluctance to walk on streets and this led to two levels of simultaneous interventions being suggested:

physical and spatial. The analytical process (1) identified the upper thermal comfort limit for pedestrians by application of the Physiological Equivalent Temperature index, ‘PET’, through use of the RayMan Software; (2) revealed that physical proximity to other people while on the street is the most sensitive socio-cultural issue in the outdoor spaces of Saudi, particularly between the opposite sexes, and that the existing pavements are generally too narrow to accommodate the preferred personal distance; (3) identified appropriate design interventions at the microscale of the street space to introduce improved shading and create air movement to reduce the impact of solar radiation and humidity and thus to contribute towards encouraging more use of streets for walking; and (4) marking the pavement to indicate distance walked along with high quality streetscape elements was shown to attract pedestrians effectively.

Such findings have significant implications for restoring the place of walking on streets in hot and humid cities and the research concludes by emphasising: (1) it is the design of the street space in climatically responsive and socio-culturally compatible ways, rather than the configuration of the urban form that is most associated with increasing physical activity; (2) there is a crucial need to redistribute the street space away from cars and towards pedestrians by widening the existing pavements both for satisfying the average personal comfort distance between pedestrians and for incorporating appropriate streetscape elements.

Dedication

I respectfully with deep affection dedicate this thesis to those who have always loved me more than themselves and for the sacrifices they have made – my family:

To my late father, who completed his mission in this life to the fullest with dedication;

To my mother, whose encouragement, advice and guidance have been always an inexhaustible resource;

To Rabab, who has endured life with a student husband for several years with great patience and selfless love;

To my children: Manal, Mohana and Moneer, whose presence in my life throughout this experience has been an invaluable asset that has always brought hope and smiles into this achievement.

Acknowledgements

First and foremost, all thanks and praise is due to Allah (Almighty God), in whom I totally believe and depend on. For without His will, bounties and His mercy, none of this work would have been possible to be accomplished. He is the first to be acknowledged and my countless thanks will never be sufficient. I ask His forgiveness if I made inadvertent mistakes, and that He rewards me if I made a useful contribution to serve the benefit of humankind.

Completing this thesis has probably been the most challenging activity of my life. Apart from my own efforts, the best and worst moments of my studies have been shared with many people who offered considerable assistance in different ways and deserve special thanks. The list of those to whom I owe much thanks is probably will not be enough to be accommodated in a single Acknowledgement section. However, I take this opportunity to express my gratitude to those mentioned here whose contribution is much appreciated.

My first debt of gratitude must go to my supervisors, Dr Simon Bell and Dr Chris Speed for their invaluable intellectual contributions since the instigation of this thesis. I would like to express my deepest thanks and appreciation to them for the great freedom and flexibility they have always given me to pursue my work independently, with full confidence. Not only that, but also their advice and guidance extended to a number of email messages from the UK to Saudi Arabia during my fieldwork. Without their patient, moral, generous and friendly support, this accomplishment may never have been achieved. It has been a great privilege to spend several years under their supervision and they will always remain dear to me.

I also place on record my profound gratitude to Dr Badran Alznafer and Dr Abdulrahman Alshaikh who were working constantly along my side and sometimes through online communication. Their mastery and passion for their PhD research assisted me in exploring the aspects associated with outdoor thermal comfort. Dr Omar Mohammed also deserves special thanks for taking a risk with discussing a research topic for which we had no precedents. All these three valued colleagues may have lost many hours of sleep when I needed to discuss some issues. Their feedback has made this research an outstanding learning experience that I will remember for the rest of my life.

I would also like to convey my sincere thanks to Professor Catharine Ward Thompson for giving me the opportunity to continue my studies as a PhD student, and the constructive advice she has always given me. Thanks must go also to Andreas Matzarakis, University of Freiburg, for kindly providing me with the RayMan Software. I have to acknowledge also the friendly cooperation I received from Jenifer Spencer for the excellent work in proofreading this thesis, as well as Fiona Hunter and Elaine Dickson for the unconditional support towards the difficulties I experienced during this doctoral journey.

I would also like to take this opportunity to express my deep debt of gratitude to all members of my large family in Saudi Arabia and Egypt, for their unconditional support and unlimited trust. I would like especially to record here the encouragement and assistance rendered by my older brothers: Mohammed, Magdy, Mamdouh, Motaz and Motasim, as well as their wives and children. My nephew Marwan deserves my heartfelt appreciation for helping me with sacrifice of much of his time in the data collection process. His assistance has meant more to me than I could ever express.

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Chapter One: Introduction

1.1 Overview

It is significant to note at the beginning that this chapter is not just an introductory chapter to give the reader a brief background of the study, but also represents an essential and integral part of this thesis as a whole. This is attributed to the fact that certain issues which constitute a solid base for the study need to be explained here. Thus, the topic of the thesis and the associated aspects, including the justifications for conducting the study in the first place are discussed.

The theoretical framework of the thesis is also briefly clarified, although it is fully discussed in Chapter Two, as a justification for the approach adopted in the study. Additionally, the research objectives and questions are presented, as well as the research methodology, limitations of the study and original contribution to knowledge. Finally, the structure of the thesis is outlined.

1.2 Statement of the Problem

Humans, innately, are pedestrians most of the time, whereas driving a car, riding public transport or even a bicycle are temporary activities or secondary behaviours that should not replace or take over the original reality. Thus, when this reality is reversed, and the genuine picture is distorted, where walking comes at the end of urban processes and design priorities as well as being overwhelmed by other means of transport; urban streets become deficient to sustain the presence of pedestrians. These simple words describe precisely the existing condition and challenge in Saudi Arabia.

In origin, the nature of the Saudi city differs from many cities founded and evolved around the world, even those in neighbouring countries. This is in regards to its formation, transformation and the influential forces that have contributed in shaping its environment, such as the social organisation, cultural structure and climate patterns. Hence, the urban street would be expected to differ as well. Owing to the accelerated and exceptional pace of the socio-economic transformations that the country had experienced by the mid-twentieth century, the narrow and irregular streets that were pedestrian-oriented were transformed into a wide and straight pattern that is more car-oriented, mimicking western street design.

Such a rapid and radical change – without proper adaptation to the requirements of the local context – has contributed to the emergence of several urban problems and lifestyle changes. One of the resulting issues is the lack of outdoor physical activity. Thus, at the beginning of the 21^{st} century, every city in Saudi Arabia has experienced the phenomenon of declining rates of walking, primarily on the streets.

The primary cause contributing to such a situation is the constant and outdated practices of street design: (1) prioritising movement of cars at the expense of pedestrians' space and requirements – not to mention the lack of public transport infrastructures; (2) dealing with the street environment on the basis of a mere space rather than a place that contributes to a better quality of life. Although these practices are somehow intertwined, walking is eventually considered by municipalities as merely physical exercise rather than a lifestyle; optional rather than necessary.

Consequently, the environmental quality of the street space, through the physical and spatial characteristics, has failed to retain much or any user-friendliness for walking or for sustaining street life. Even the effect of street improvement in almost all cities since 2009 has not been sufficiently effective to encourage walking or to restore pedestrians to the street.

The urban street is losing its vibrancy and dynamism, and even the pedestrian's space is being compressed and degraded as the daily landscape. Chief among the basic design requirements that have been neglected is providing conditions of outdoor thermal comfort in a country located under a very hot-arid climate and, in some cities, accompanied by high levels of humidity. This approach was coupled with underestimating the influential role of certain socio-cultural aspects that govern the Saudi society in street design.

Lack of consideration of these requirements has contributed in forcing pedestrians to withdraw to other urban places for walking. This means the dedicated street space for cars constantly undergoes widening processes, whereas the other urban places have recently witnessed increasing rates of walking – which raises alarming signs that pedestrians are disappearing from the street space, and hence it is losing the major component for its vitality.

Such a situation demonstrates that pedestrians are no longer satisfied with the qualities of existing streets – or that conditions of urban streets per se have become deficient in fulfilling outdoor pedestrians' needs and expectations. This can be attributed to the fact that they have experienced better places providing for their needs.

Accordingly, pedestrians have become in crucial need of the car use every time they want to practise walking; although walking is, by nature, the most basic and simplest form of physical activity (for purposes of transport, health, recreation and social interaction) to be performed anytime, anywhere, without additional procedures. There is no better place that meets these criteria than the urban street; if so, why have pedestrians moved outside its space? This leads to posing an essential question: what is wrong with driving over walking?

Frankly, driving per se is not an issue, but the problem lies within the bias of street design that has reinforced the complete transformation of the society into the culture of private car dependency – even for the shortest daily journeys (e.g. going to the neighbourhood mosque). Streets have eventually become exclusive for motorists, whilst pedestrians have become secluded and even unwelcomed in their daily landscape. Providing pavements per se does not ensure the street will be used for walking: other basic components and considerations are also essential.

1.3 The Purpose of the Research

In practice, the enormous urban sprawl that most cities are witnessing means "more time devoted to driving a car" (Anshel, 2014: 147). Thus, the necessity of car use as a prerequisite to reach certain urban destinations that are dedicated to, or more convenient places for, walking is greatly discouraging pedestrians from maintaining walking on a daily basis, and, most importantly, as a lifestyle. In support of this postulate, several studies mainly conducted in the most developed countries, repeatedly prove that among the most common barriers people cite for not adopting a more physically active lifestyle is the lack of time (e.g. Reichert et al., 2007;

Buckworth et al., 2013). The lack of time goes beyond actual walking time, as it includes driving time to and from such places (Anshel, 2014).

Such a behavioural change has great implications, so that the increasingly sedentary lifestyle is leading to significant health problems and occurrence of lifestyle diseases in the Kingdom. Therefore, rediscovering and reclaiming the streets as an everyday landscape for walking; rather than being 'anti-car'[1] (Calthorpe, 1993; Hazel, 2003; Marshall, 2005; Gehl, 2010), is at the top of the most pressing challenges and unaddressed urban problems that face both Landscape Architecture and Urban Design in the Saudi cities.

Moreover, several studies have been conducted to understand the causal relationships between the built environment and physical activity. However, most of these studies were concentrated in temperate climates, and the role of socio-cultural aspects, through which walking as behaviour and activity is governed and guided, is almost negligible. Hence, it is of great importance to identify, examine and understand the relationship between the components causing pedestrians' withdrawal from the street space – or the associated factors hindering street use for walking – to better understand how street space can be reclaimed to restore walking and pedestrians. Significantly, this entails providing sufficient data regarding pedestrians in Saudi Arabia – which have not been made available before. More explicitly, the overall aim is:

> To broaden the understanding of pedestrians' requirements, attitudes and preferences, in order to identify ways in which the neglected street space can be reclaimed to restore walking under hot-humid climatic conditions and to inform decision-making into improved street design.

1.4 Background of the Problem

Typically, large-scale urbanisation processes occur over a long period of time, allowing urban policy-makers to reassess what was achieved and introduce changes

[1] Realistically, competing with what the car is offering may seem a premature idea in Saudi Arabia, particularly in light of the lack of competitive alternatives at present. However, while writing this thesis, the capital city Riyadh witnessed by end of 2013 the launch of construction of a Metro project for the first time in the Kingdom (Newman & Kenworthy, 2015: 11). The project represents the biggest of its kind in the world (Al-Ghoneim, 2013; Koelbl, 2013).

if necessary. Similarly, urban dwellers become gradually adapted to the new setting, hence responding to any emerging challenges that could impose adverse effects on their built environment and the quality of their life (Alznafer, 2014; Hass-Klau, 2015). In contrast, in Saudi Arabia this process has occurred at an accelerated pace over a very short time, by all standards, owing to the oil discovery in 1938 and the massive revenues it generated. This discovery has always been recognised the most significant turning point for many events and changes the country has witnessed.

It was the key source in transforming Saudi from a merely desert country with mud-built towns following the traditional compact pattern of the Arab city into a modern kingdom. However, as much as this discovery has brought prosperity to the society, so much has it directly resulted in unprecedented dramatic transformations to the vernacular built environment and people's lifestyles.

The root of the problem goes back to the Arabian American Oil Company (ARAMCO), when it was tasked by the government, in 1947, with producing a master plan to control and manage the chaotic and unplanned growth of two emerging settlements near the oil fields; Dammam and Khobar[2]. The move towards ARAMCO was natural, given that the company was the only available and capable option to assist the government, particularly in the light of the lack of qualified local competencies at that time. Therefore, relying on ARAMCO engineers, who were mostly Americans unfamiliar with the local culture, tradition and climate pattern and relied heavily on their own background; the resultant layout was, not surprisingly, an American model (Al-Hathloul, 1981; Al-Naim, 2008b).

Kimball (1956 cited in Al-Naim, 2008b: 118) emphasises that the development of the two emerging settlements was completely an imitative and imported American product, based on the South-Western town planning model and Californian lifestyle. Consequently, ARAMCO introduced in 1947 and 1952 "the system of blocks and gridiron pattern for the first time in Saudi Arabia" (Al-Hathloul & Anis-ur-Rahmaan, 1985: 206) (Figure 1.1). This coincided with the advent of the car to the Kingdom, in the previous few years. In the same context, it was acknowledged that the Saudi

[2] A community that had been formed as a result of accompanying activities to the construction of a new pier for the purposes of accommodating incoming new materials and oil shipments.

society admired the Western culture and lifestyle (Fadan, 1983; Abu-Ghazzeh, 1997; Al-Naim, 2008b). Thus, both the new layout and the car, as a complete copy of the American model, were warmly welcomed, so that "The cultural transfusion between the early Americans and the residents [was] inevitable" (Al-Said, 1992: 215).

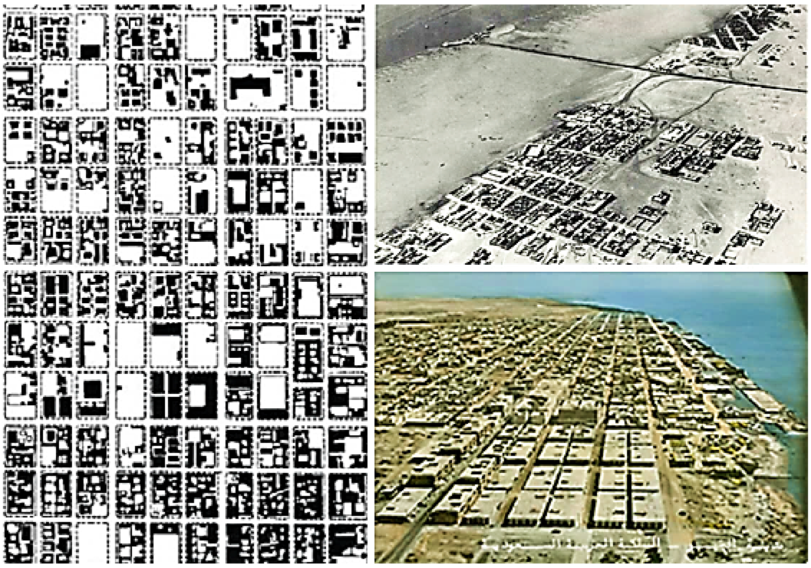

Figure 1.1 Emergence of the first gridiron pattern in a Saudi city was proposed by ARAMCO in 1947 (Sources: Dammam Municipality, 1997: 35; Al-Naim, 2008b: 120)

Indeed, both components were considered inevitable alternatives to the traditional compact built environment that was perceived as an obstacle in the way of modernity (Al-Hathloul, 1981; Al-Said, 1992; Al-Naim, 2008a; Alznafer, 2014). After a short time, the car has increasingly become at the top of the Saudis' priorities. In the same vein, Al-Hathloul (1981) decisively demonstrated that the grid as a street pattern, the car as a preferred transport mode, and the villa as the new house type all became favoured "models for the new physical development that took place in the 1960's and 1970's in every city and town in Saudi Arabia" (Al-Hathloul, 1981: 165).

Worth mentioning here is that the transfer of managing the built environment from the residents – as was the case in the traditional city – to become governed under institutional practices echoes the thesis that "standardized designs create anonymous landscapes [that] could be built in any town or city" (Bell, 2013: 674). Thus, environmental qualities that distinguish any place from another (e.g. topography, climate) have become neglected, and urban places failed to retain any distinctive character.

Indeed, the grid plan combined with the new standardised street characteristics, building codes, zoning and land subdivision regulations – established after the mega-projects carried out in the capital Riyadh in 1953, 1973 and 1982 respectively – were followed in every city until today, irrespective of any environmental qualities. Accordingly, the urban character of Saudi cities has become to a great extent identical. Most importantly, between 1980 and 1990, driven by the vast revenues from the oil boom in the late 1970s, all the major cities witnessed unprecedented rapid growth of urban-based economy and population, which was intensified by large migrations to the Kingdom. Therefore, there was an urgent need for constructing large-scale infrastructures, mainly highways, railways, ports and fundamental industries, so as to boost the economic base and "to accommodate the increasing demand for new residential units and the ever-increasing number of automobiles in the city" (Alznafer, 2014: 6).

Accordingly, other developments (e.g. public transport, neighbourhood parks and other urban facilities) only fulfilled the most basic standards. Seemingly, there was no time or effort spent to reassess the new built environment, owing to the acceleration of the urban activities and the resultant urban sprawl. Such a situation, consciously or not, has exacerbated the reliance on cars and even indoor spaces for walking, while the quality of the inhabitants' life has somewhat degraded outdoors. Realistically, providing the pavement per se does not ensure walking; rather, people in Saudi Arabia are in desperate need of other basic imperatives to encourage them to withstand the journey as pedestrians, particularly under harsh climatic conditions in a car-dominated society and with certain socio-cultural requirements.

In this context, it is irrational to criticise people when they do not walk out of doors if pavements do not exist in the first place; however, it is a central issue to probe why pedestrians are moved to walk in other urban places if pavements are already built in almost all streets. This observation, indeed, stimulates us to make every effort to understand the relationship between the current conditions of urban streets and the behavioural change of pedestrians in refraining from using streets for walking.

The bottom line for the issues associated with the research problem is: **(1)** characteristics of street design that, in every detail, prioritise movement of cars over pedestrians; **(2)** increasing rates of walking in indoor and outdoor places, but not streets; and **(3)** lack of context-sensitive practices in street design that are climatically-responsive and socio-culturally compatible. Therefore, the complex ecology surrounding walking poses challenges to the urban space researcher and designer interested in gaining a better understanding of how walking can be restored into the street space.

1.5 Significance of the Study (magnitude of the problem)

1.5.1 Lack of data on pedestrians in Saudi Arabia

Saudi Arabia is not only a developing country that is still lacking in appropriate scientific studies, but is also a unique case study to explore. Indeed, there is increasing acknowledgement that urban spaces in the Middle East, including KSA are in significant need of more cultural and socially-relevant design solutions (Thomas, 2012). This cannot be addressed properly if the pertinent information about the users does not exist in the first place. Once a site has been selected and the function has been identified, then at the top of the primary priorities that must be made available as early as possible are the requirements and expectations of the targeted users (Fogg, 1989; LaGro, 2008). Thus, designers, architects and planners would be in a better position to offer the appropriate intervention. Similarly, Al-Abdullah (1998) asserts that any landscape architecture design process cannot be successfully fulfilled unless “sufficient information is available about the users and their activities at the project site” (Al-Abdullah, 1998: 16).

Moreover, Gehl (2010: 196) stresses that many important urban-related decisions must be made for the human scale on the microscale, and hence “a wealth of information should be obtained”. Nevertheless, it is seldom possible to find complete or even reliable data about users at this scale, which often makes it “a difficult and rather intangible scale to work with”. For Saudi Arabia, the necessary information about the role of the pedestrians’ requirements in designing the contemporary streets does not already exist, because as Beer and Higgins (2005) explain:

> “Too often, sites are planned and designed in relation to the designer’s own life experience and opinions, without adequate understanding of how those most likely to use a site, who may have different outlooks and needs, might wish to behave within it” (Beer & Higgins, 2005: 84).

This is exactly the current practice in the Kingdom, where no one has attempted to observe the actual pedestrians, talk to them and ask what attitudes they hold. Explicitly, the scarcity of pedestrian-related data in Saudi Arabia, in terms of the influential socio-cultural aspects regarding walking and conditions of outdoor thermal comfort they require, not only creates a false impression that walking is not important in the Saudi context, but also places further challenges in front of this research.

1.5.2 Behavioural change towards a sedentary outdoor lifestyle

Owing the tremendous urban sprawl, combined with the lack of mass transit systems, rapid growth of shopping malls and failure of urban streets to foster walking, outdoor pedestrians have been gradually disappearing from the street space. Such a societal change has accelerated the transformation of the country into a culture of being a car-dependent society. This in turn has contributed in exacerbating the phenomenon of a 'sedentary lifestyle' outdoors (Schweizer et al., 2014; Magold et al., 2014; Hiron et al., 2014).

A few published sources attribute the general lack of an active lifestyle, particularly daily walking, to the complete dependence upon the intensive use of private cars (Dawoud et al., 2011; Khushaim, 2013). Both sources agree that the proportion of the population practising physical activity does not exceed 25%, at most. According to the World Health Organisation (WHO, 2011), the Kingdom was ranked the highest for physically inactive societies, with over 68% among those aged ≥ 15 years[3] undertaking insufficient physical activity (Figure 1.2).

[3] The reader is advised here to be aware that the 25% is based on the total population, while the 68% is only related to those aged 15 years and above.

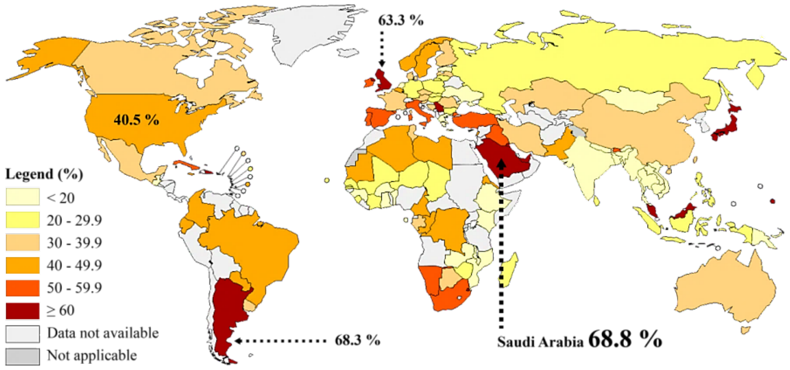

Figure 1.2 Saudi Arabia was ranked as having the highest level of insufficient physical activity among the world's adults aged ≥ 15, for both sexes (Source: WHO, 2011)

1.5.3 The increase in the culture of being a car-dependent society

In connection with the previous point, in fact, any discussion about the decline of walking rates in urban areas is mostly inseparable from the increasing growth of the culture of a car-dependent society (Kenworthy et al., 1999). Such a statement, although literally true and beyond the main focus in this thesis, is nevertheless an informative indicator. Thus, after the rapid economic growth of the Kingdom took place, "Walking has long been seen as second class travel, and combined with hot summers and low fuel prices, the car and its needs were king" (Fraser, 2012: 26).

Following the oil boom, the population in the early 1980s was about 9.3 million people and the number of private cars was up to 2.1 million units (Alshaqty, 2012). This means the population was almost four times the number of cars; or one car for every four individuals. However, it was not long until this proportion dramatically changed. While the Kingdom's population was about 27.6 million inhabitants in 2010, the number of registered private vehicles[4] was 13.5 million cars, i.e. an average of one car per two inhabitants or 488 for every 1000 people. In the same vein, while estimates for private car sales in 2011 ranged between 737,000 (Argaam, 2013a) and 800,000 units (Al-Ghamdi, 2012), 2012 achieved a record high with 982 thousand cars (Argaam, 2013a) (Figure 1.3).

[4] This refers only to cars and light trucks (SUVs and pickups) that are used for personal travel.

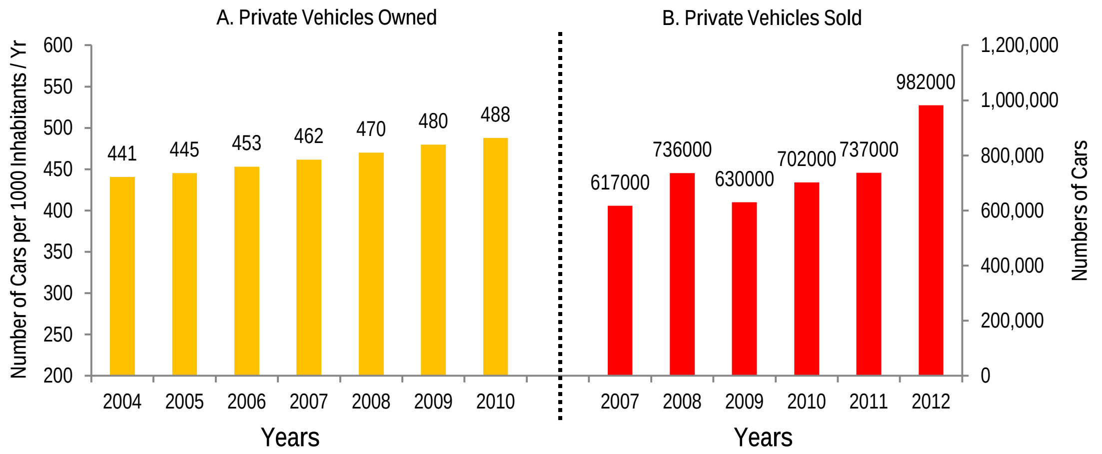

Figure 1.3 Number of private vehicles per 1000 inhabitants per annum and car sales in Saudi Arabia (Sources: A. produced by the author based on statistical spreadsheets obtained from CDSI, 2011; B. Argaam, 2013a)

Moreover, the targeted number of private cars, anticipated to be sold, could reach one million cars a year by 2020, due to the increased local demand (Al-Ghamdi, 2012; Argaam, 2013b). However, the average annual growth was around 700 thousand cars, i.e. 5.4% per annum in 2010 (Alshaqty, 2012) or 7% as per 2013 (Argaam, 2013b), while the population is growing at an average of 2.5% annually (CDSI, 2015). Accordingly, in the light of this population growth rate and the growth of cars at a doubled rate, then it is predicted that numbers of cars could be equal to the number of the population by around 2036 (Figure 1.4), with one car for each individual (Alshaqty, 2012).

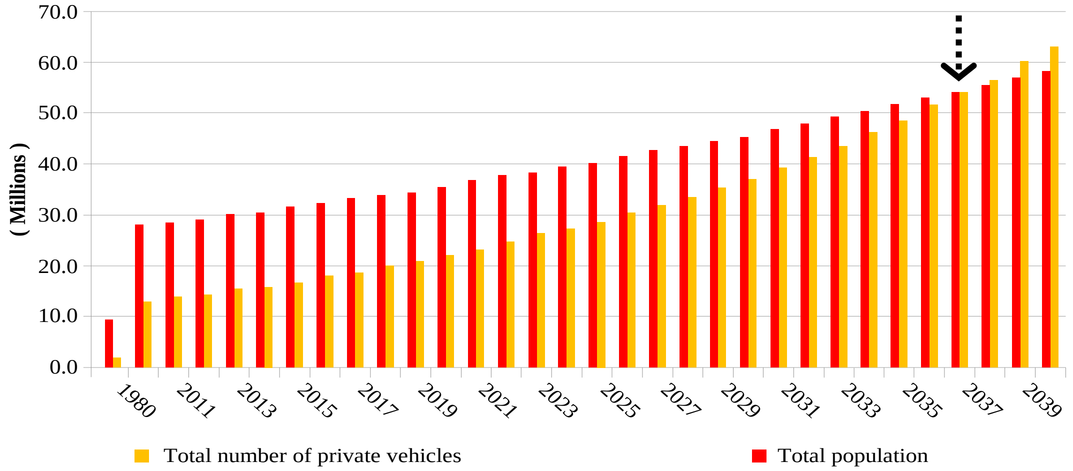

Figure 1.4 A comparison between the increase in population and number of private vehicles in the Kingdom - past, present and predicted (Source: Alshaqty, 2012)

1.5.4 Health issues

In the last fifteen years, studies on how to encourage people to engage in more daily physical activities – mainly in relation to the characteristics of urban spaces – have increased as a result of the change in lifestyles that are often linked with health issues (e.g. Handy, 2005; Gehl, 2010). The same holds true for the KSA where the lack of accessibility to walking on a daily basis – and here the urban street plays a substantial role – has been identified as a contributory factor leading to significant occurrence of lifestyle diseases (Al-Ansari, 2014), because walking "in city space is more than an environmentally friendly form of transport [...] It promotes health as well" (Gehl & Svarre, 2013: 73).

The situation described in the previous paragraph is bound to result in fallout to the Saudi society; thus it is not a coincidence that the increasingly sedentary lifestyle has placed the Kingdom at the top of the list of lifestyle-related problems. The following paragraphs show the extent to which the level of physical inactivity and thus health issues in Saudi Arabia requires serious attention.

(1) Obesity Rates

Lifestyle-related diseases have been widely accepted to be connected with the change from active to sedentary behavioural patterns (Gehl, 2010; Ward Thompson et al., 2010; Özdemir, 2013). One of these conditions is obesity. According to the WHO, the obesity rate is an important social indicator, widely used to characterise the lifestyle of communities, and can be defined as referring to individuals with a Body Mass Index (BMI) ≥ 30[5].

Obesity has recently come to be regarded as a growing lifestyle-related disease in the KSA (Dawoud et al., 2011), and the country was ranked top of the list of the most obese and overweight societies in the world. The total population in 2010 was 27.6 million, of which the number of the adult group ($\geq$ 15 years) constituted 19.2 million (CDSI, 2014). Among this category, about 35.6% (i.e. 6.8 million) were obese (WHO, 2011)[6], which represents almost 25% of the total population. Those

[5] This figure represents a measure of an individual's body weight divided by the square of the height, with the value being given in units of kg/m^2.

[6] Jan Gehl (2010: 110) indicated the rate was 35% by 2010.

classified as overweight (25-29.99 kg/m^2) is even greater; one in every three people is overweight (Koelbl, 2013) (Figure 1.5).

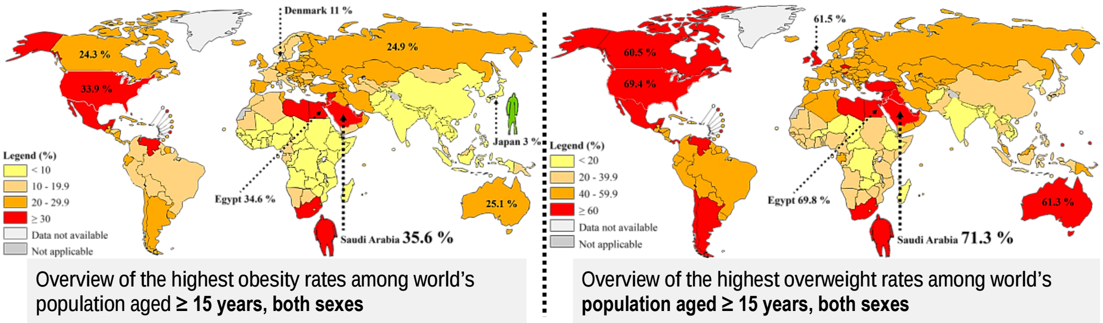

Figure 1.5 Obesity and overweight prevalence rates among world's population aged ≥ 15 years, both sexes (Source: WHO, 2011)

Moreover, the WHO report (2013: 115) showed that Saudi Arabia had recorded a slight increase in the obesity rate, which reached 36.5%. The CDSI (2014) estimated the total population for 2013 was almost 30 million and the adult group was slightly under 21 million. Based on these data from both sources, the total number of obese individuals could rise to about 7.6 million or 25.2% of the total population. This proportion is relatively close to one of the research findings of this study (see 6.2.1.2 – 4c), although the sample size may not be significant for generalisation.

Figure 1.6 below further shows the amount of the change of obesity in Saudi Arabia has risen sharply by 14.9% within 20 years. What is more interesting to mention here is the female group has always recorded higher rates than those for males – even in the findings of this research (Figure 6.9), which has been confirmed by another study in 2011. Dawoud et al. (2011) drew attention to an alarming and growing increase in obesity throughout Saudi society. They pointed out that 70% of men and 75% women were obese among the survey sample (n = 2800).

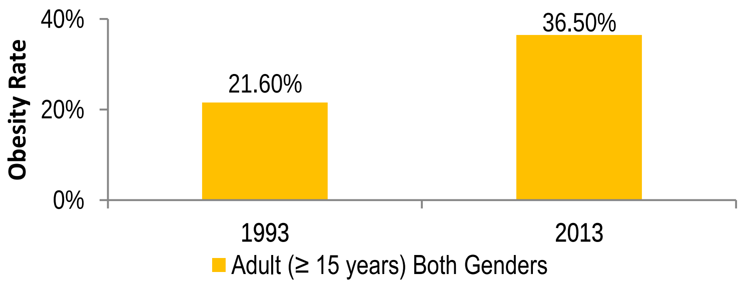

Figure 1.6 Growth of obesity rate among the Kingdom's population in a 20-year period (Source: the author based on the WHO data spreadsheets, 2013)

(2) Diabetes Rates

It is not surprising that Saudi Arabia, with its high rates of obesity and overweight individuals also has the highest diabetes rates (Figure 1.7). It has been acknowledged that there is a close association between the lack of physical activity, prevalence of obesity and diabetes rates, which are observed in the Kingdom to be among the highest in the world (Al Awaji, 2010; Dawoud et al., 2011; Koelbl, 2013). It has also been accepted that the underlying reason for the growing numbers of diabetics in Saudi Arabia, for which estimates range between 17 and 25% of the total population, is the lack of an active lifestyle as part of the daily programme (Khushaim, 2013).

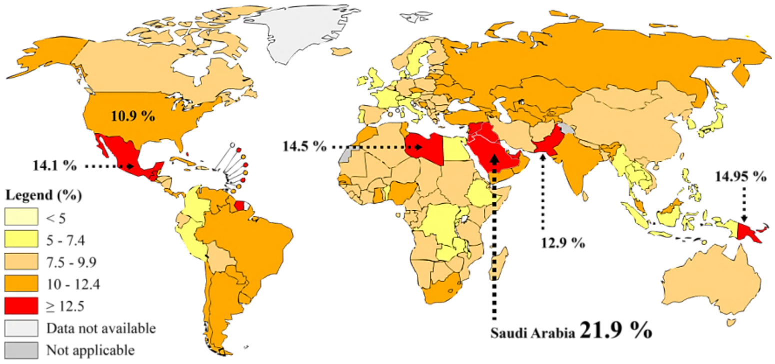

Figure 1.7 Saudi Arabia was ranked the highest for prevalence of diabetes among the world's adults aged ≥ 25, for both sexes (Source: WHO, 2011)

The information discussed in this section strongly supports the significance of carrying out this study and makes it a valid research topic, which needs to be addressed before it becomes too late and pedestrians completely disappear from the street. Therefore, there needs to an approach for street design that can contribute to the improvement of pedestrian health and an overall better quality of the inhabitants' outdoor life through an active lifestyle.

1.6 Justification for this study

After clarifying what is to be achieved and how it was instigated by the fact that the decline in walking is a result of several factors leading to several consequences; it is necessary now to explain why this research is very timely. The following paragraphs justify and support the need for such a study.

In origin, any study most often begins with a topic interesting to the researcher due to a number of considerations, incentives or multiply intertwined factors. Whatever the motive is; the author believes that the best starting point to clearly understand the pertinent issues as a landscape architect lies mostly in everyday real-life experience.

Therefore, in order to have a representative, realistic and up-to-date picture of the issue and context under investigation, “there is no better research method than walking down the street and watching what really goes on” (Crabbe, 2014: 11). This implies reviewing whatever media or sources are available to the researcher, whether written or verbally.

(1) The lack of similar studies in the Saudi context

During a pilot study in 2010 to serve the aim of an initial research topic, which has subsequently shifted into a totally new direction as presented in this thesis; two major issues were observed:

a) An overall lack of pedestrians using streets for walking, and
b) The proportion of Saudis among those pedestrians compared to the proportion of non-Saudis is considerably lower, although the Saudis constitute the largest segment of the society (CDSI, 2015).

Most importantly, during the progress of the activities of this research, it has been noticed by the author that the issue of the decline in walking, particularly on the streets, has become a hot topic in Saudi society (Figure 1.8), so that there are:

a) Increasing public appeals in the last few years to promote the culture of walking (Dhaif-Allah, 2015) and
b) Growing public dissatisfaction, questioning the quality of contemporary streets to foster walking, with particular emphasis on improving conditions of the pavements (Al-Muhaisin, 2014; Alsulami, 2015).

These latter points constantly recur in the pages of newspapers and internet forums, and provide deep and rich insights. Through reviewing these available sources, the public identify some of the underlying aspects behind their reluctance to walk on streets, which are similar to those found in this research. Generally, they attribute the causes of the problem to two categories: (a) the poor quality of pavements in terms of physical properties, visual characteristics, construction and finishing materials; and (b) the impact of the local climate without climate-responsive urban design such as shading.

الرياض الاقتصادي

الثلاثاء 06 ربيع الأول 1435 - 07 يناير 2014م - العدد 16633

إعطاء الرصيف حقه... يوقف ضخ المليارات لعلاج أمراض قلة المشي

المتخصصون يطالبون بتصميم الأرصفة لتكون صديقة للمشاة

الرياض- فهد الفهيد

دعا الدكتور صالح بن محمد الأنصاري الأستاذ المساعد في طب الأسرة والمجتمع والمشرف العام على مركز تعزيز الصحة إلى إيجاد حل جذري للتعامل مع انتشار الأمراض المزمنة الناتجة عن الخمول وقلة النشاط البدني، أو ما نسميه أمراض النمط المعيشي، مؤكدا أن هذا الحل لابد أن يأتي من "خارج الصندوق" وليس له علاقة كبيرة بمصروفات الخدمات الصحية في الجانب العلاجي.

A. Putting the pavements to rights would stop draining billions to treat lifestyle-related diseases.

النسخة الالكترونية | النسخة الورقية | الأكثر قراءة | الاعلانات المبوبة | تسجيل دخول

الاقتصادية

تابع @aleqtisadiah

الاولى | آخر الأخبار | أسواق وأرقام | أخبار | عقارات | FINANCIAL TIMES | الرأي

الاثنين 1432/3/4 هـ الموافق 07 فبراير 2011 العدد 6328

انت الآن تتصفح عدد من الأرشيف، نشر قبل 1400 يوم . عودة لعدد اليوم

النقاش

للنقاش: هل تساعد شوارعنا على تشجيع المشي؟

فكرة النقاش تم استقبالها عبر البريد الإلكتروني من قارئ اكتفى بوضع اسمه الأول:عبد

تتوفر مواقع عديدة للمشاة في المملكة لكن تلك المواقع عادة لا يتم الوصول إليها بسهولة كونها تقع عادة في وسط المدينة أو في أماكن تعج بالحركة المرورية .

يردد البعض أن الأرصفة في الشوارع غير المخصصة للمشاة لا تشجع على المشي من جهة ولا تراعي ظروف ذوي الاحتياجات الخاصة من جهة أخرى كما أنها تتفاوت من شارع لآخر بل وفي الشارع الواحد صعودا ونزولا ولا يفاجئ من يراها بأنها تختفي فجأة لبناء مواقف لمحل ما، الأمر الذي يجعلها طاردة للمشاة، لتصبح أرصفة المدن غير صديقة للمشاة .

ما اقتراحاتك لتحسين الأرصفة وجعلها مناسبة للمشاة ؟

يرى البعض أن الناس في بلادنا اعتادوا التنقل بالسيارة، ما رأيك؟

شاركنا النقاش

B. An online article questions how the pavements can be transformed and restored for walking.

Figure 1.8 Samples from newspapers reflect the growing attention to restoring the pavements for walking (Sources: A. Alriyadh newspaper, No. 16633, 7th Jan. 2014; B. Aleqtisadiah newspaper, No. 6328, 7th Feb. 2011)

(2) Constant practices to seclude pedestrians outside the street space

In an explicit recognition of the scale of the problem under study in this thesis, Alsultan[7] (2013) confirms that the on-going use of urban design tools has always resulted in the failure of streets to retain much or any user-friendliness for walking. This, indeed, echoes the thesis that contemporary streets have become the victim of outdated thinking caused by entrenched practices (Newman & Kenworthy, 2000; Campbell & Cowan, 2002). According to Koelbl (2013), Alsultan argues there are more six-lane highways than sidewalks. Saudis spend their entire lives moving between the air-conditioned interiors of their homes, their cars and the shopping mall, thus pavements have become underappreciated space immersed in the world of

---

[7] The present president of Arriyadh Development Authority.

neglect. To address this, some efforts have been made to tackle these growing phenomena; the first outcome was applying the concept of pedestrianisation.

This concept was developed for two of the busiest and oldest shopping streets in Riyadh in the late 1990s, and failed. Nevertheless, owing to persistence of the former Mayor of Riyadh[8] to achieve his vision; the city constructed the first walking tracks[9] in Saudi Arabia in mid-2000s. Soon, these places gained popularity and have rapidly become a must-have model in other cities since 2009. Due to the growing appeal of this concept to pedestrians, Arriyadh Development Authority carried out an online poll on 14 December 2011, exploring to what extent the constructed tracks are sufficiently distributed. The results revealed that 87% of the participants expressed their desire to have more similar places (Figure 1.9).

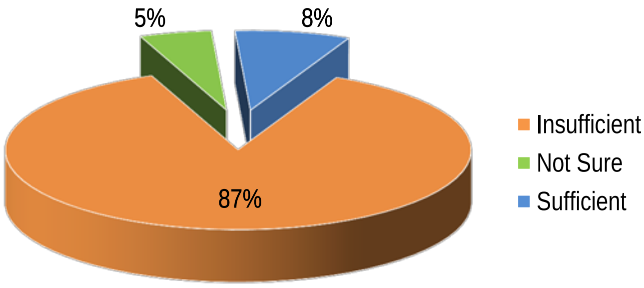

Figure 1.9 A poll measures adequacy of the number of walking tracks in Riyadh (Source: the High Commission for the Development of Arriyadh, 2012)

However, as much as the public interaction with this poll reflects their tendency for walking, it equally demonstrates the insistence of urban policy-makers on considering walking as an exercise rather than a lifestyle – and hence the belief that pedestrians should be isolated outside the street space. The problem with this approach, in addition to the financial burdens, is attributed to the fact that such urban places are designed as stand-alone projects, necessitating car use every time.

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[8] Prince Bin Ayyaf, who raised the slogan of the “human city” for the first time in Saudi and took the responsibility for transforming the capital into a more human-friendly place (Al-Naim, 2008b: 149).

[9] A walking track is a paved path constructed and reserved solely for the purpose of walking within the urban fabric. The design of this project is always built in the form of a loop that typically surrounds neighbourhood parks or vacant municipal lands, not only to serve the nearby residents but also the city as a whole.

What is more, there is a very recent proposal, which still under consideration by several government bodies, that aims to legislate the inclusion of walking tracks inside shopping malls (Akhbaar24, 2015) (Figure 1.10). Such an idea, although it may seem to "turn a blind eye" to the real challenges that are limiting opportunities for walking outdoors, nevertheless, evidently demonstrates the growing interest shown towards walking. It also places great emphasis on the current practices of urban design that have failed to create locally context-sensitive streets, thus, in turn, continuing to push the public life indoors.


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توجه لإنشاء مضامير للمشي بالمولات والتوسع في مراكز رياضة المرأة

أخبار 24 21/02/2015

تدرس جهات حكومية، عدة مقترحات حول برامج ومشروعات جديدة تتصل بالرياضة والصحة البدنية، وجدوى تطبيقها بالمدن السعودية.

أوضحت مصادر، أن المشروعات المقترحة عبارة عن توصيات خرجت بها ورشة عمل نظمتها الأمانة العامة لمجلس التعاون الخليجي العام الماضي في مدينة دبي، وفقاً لصحيفة "مكة".

وأبانت أن من بين المقترحات توفير مراكز وأماكن للمرأة لممارسة النشاط البدني، وتخصيص مضامير للمشي بالمجمعات التجارية، إلى جانب زيادة المراكز الرياضية بالأحياء وعدم قصرها على المدن الرئيسة، وتخصيص مسارات للدراجات الهوائية وغيرها، بالإضافة لتشجيع القطاع الخاص على الاستثمار في مجال الترفيه.

Figure 1.10 This screenshot shows that the government is discussing proposals to enact a law that imposes walking tracks to be incorporated in all existing and under-construction shopping malls (Source: Akhbaar24, 21st Feb. 2015)

1.7 Case study: Dammam City

It is very beneficial to justify the underlying factors for selecting Dammam as the case study area in this thesis. But before doing so, it should be clarified now that the word Dammam is commonly used to refer not only to Dammam city, but to a large municipal urban mass known as the Dammam Metropolitan, consisting of three urban centres located in the Eastern Province. However, the use of Dammam in this thesis refers to the city itself at the centre of this area (Figure 1.11).

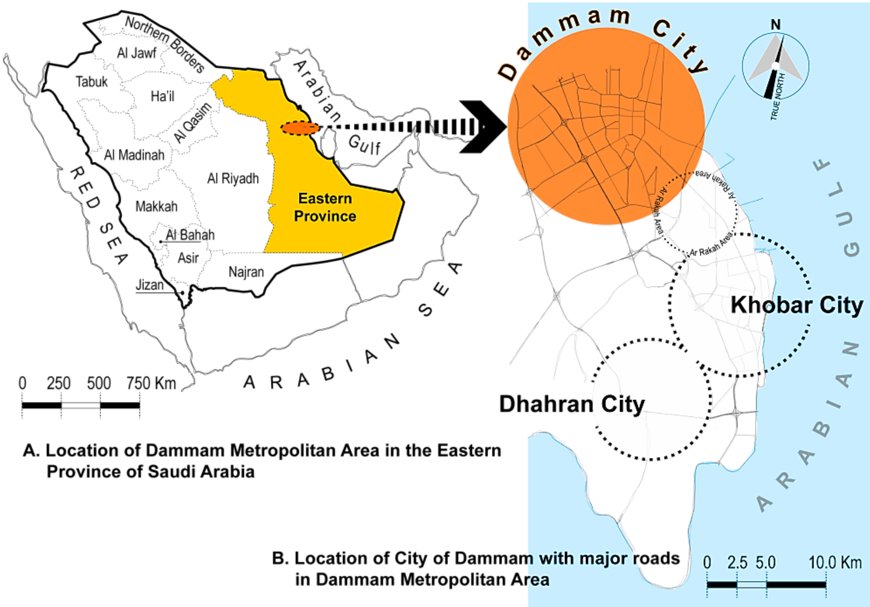

Figure 1.11 Location of Dammam City in Saudi Arabia (Source: the author)

Saudi Arabia is a large tract of land that is divided into 13 administrative provinces encompassing several major cities with various differences in terms of diversity of cultural background, topography, climate and vegetation as well as size of the built environment. Coupled with the fact that each area is affected by different factors (e.g. geographical location, historical role, economic influences), it becomes very hard to cover the issue of walking and urban streets for the whole country in a single research study. Therefore, minimizing the research scope which will permit more detailed and comprehensive study is crucial.

In addition, the urban character and street patterns are almost identical in major cities; owing to the radical urban changes that Dammam has experienced, it is considered a milestone that “led the way and set up a model which other Saudi Arabian cities were to follow in the 50s, 60s and 70s” (Al-Hathloul & Anis-ur-Rahmaan, 1985: 207). Dammam drastically differs from other cities in terms of its formation, where the city was built almost entirely from the ground up after the oil discovery. Accordingly, it is an urban environment designed from the outset following principles of the modernist architecture and planning parallel with rapid advancement in transport.

Moreover, Dammam is the hometown of the author, hence the most familiar Saudi city to him, in terms of a thorough understanding of the city’s history, environment and urban development that the city has experienced. In fact, the researcher himself is a witness to a part of the transitional and transformation period of the evolution process of the city that has taken place from the second half of 1970's. Accordingly, based on the author background as a landscape architect for twenty years of experience, it is obvious that the city is lacking in a futuristic vision that identifies its strategic plan in addressing the decline in walking. Coupled with observing the city coping with its urban challenges on a reactive basis to emerging problems, the city becomes an even more challenging case for study.

1.7.1 Brief historical background of Dammam

Until the turn of the 20th century, Dammam was not an existing physical entity (Dammam Municipality, 1997; Al-Abdullah, 1998). The foundation stone for its emergence goes back to a clan (Al-Dawasir) displaced from Bahrain[10] around 1921/23 (Al-Shuaiby, 1976; Al-Said, 1992). Following the prevailing pattern of Arabian Gulf cities, they established a tiny fishing and pearl diving hamlet, where the spaces between the few huts were small; streets were skinny and organic.

In 1938, the great year for Dammam and the entire country, oil was discovered in quantities sufficient for commercial production about 12km to the south, in the Dhahran area. This discovery, in every sense, launched the beginning of the dramatic transformations which this simple village has witnessed. Proceeding from the time the gridiron pattern and the car were introduced; the face of Dammam, its street life and the inhabitants' lifestyle in moving around in the city have gradually changed. Local people found themselves living in an unprecedented and alien environment in a very short time. It has been acknowledged clearly that:

> "Within three decades, the sleepy little fishing village grew exponentially and became the capital of the Eastern Province. No area of the Middle East, or perhaps the world, has undergone such dramatic transformation in such a short period of time" (Al-Ghonamy, 2010: 48).

Since then, the city has been expanding almost in all directions, even towards the shallow shelf of the natural boundary of the Arabian Gulf, which has witnessed massive filling or land reclamation processes to fulfil the increasing demand for

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[10] An off-shore island country in the Arabian Gulf.

residential and recreational purposes (Al-Abdullah, 1998). Accordingly, from 1350 dwellers in 1935 (Al-Shuaiby, 1976), the city has exceeded one million inhabitants, according to 2015 estimates (CDSI, 2015). The city is the fifth largest Saudi city by population.

1.7.2 Compression of the pedestrian space by continuous outdated practices of urban design

It has been already observed in Saudi Arabia it is very hard to find any differences between two streets in two different cities (Al-Awais, 1991). During the period following the oil boom, the urban space rapidly became *lost space* (Trancik, 1986) – mainly owing to the dominance of the car – while the pedestrian space was gradually compressing. By 2009, moreover, driven by the oil revenues, Dammam, among other cities, had undergone massive upgrading process in the public realm. For Dammam, this can be described as the first city-wide regeneration process since its formation. This process, although still in its final stages, was confined to the urban public spaces: namely, streets, sea front developments and neighbourhood parks. However, the main streets have received the largest share of attention and funding, while improvements to neighbourhood streets have been limited to re-asphalting.

Without an overall vision and review of the effects of the previous decades of prioritising the car in street design, the renaissance of street spaces was primarily focused on: (a) building new highways, (b) establishing automobile bridges and tunnels for the first time within the city fabric, whilst widening existing streets, (c) replacement of standard lighting, (d) alteration of paving materials, and (e) incorporating steel fences along the central reservation.

Therefore, new traffic spaces were gained to alleviate the increasing traffic congestion, either at the expense of the central reservation, the pavements, or both. The current practices of designing the street space are still using the same tools that prioritise the car over the pedestrians, and hence have made pavements and the walking experience unsafe, unpleasant and uncomfortable in Dammam. Such a situation, indeed, echoes the thesis that “if you plan cities for cars and traffic, you get cars and traffic. If you plan for people and places, you get people and places” (Kent, 2005). Eventually, the pedestrians in Dammam have only three places where they can practise walking; namely, the emerging walking tracks, Corniche walkways, and shopping malls, all of which necessitate use of the car to access them.

1.8 Research questions and objectives

Although the contemporary built environment has deeply affected the use of streets by pedestrians, there is a growing trend for walking outside the street space. Therefore, the principal research question that this dissertation attempts to answer in an explorative way through an empirical field study is:

> How can the neglected street space be reclaimed to restore walking under hot-humid climatic conditions with certain outdoor socio-cultural requirements, in order to inform decision-making into improved street design?

Consequently, five sub-questions are formed and serve as the basis for answering this key research question:

(1) What is an appropriate approach to understand the factors affecting walking on urban streets that are specifically important to Saudi Arabia? Is it possible to construct a holistic theoretical framework for restoring walking into the street space?

(2) How the decline of walking on urban streets has been addressed in the literature? What theory of pedestrian-behaviour is most compatible to the most important socio-cultural aspects related to outdoor life for the Saudi context? How can the concept of outdoor thermal comfort be achieved and optimised on the microscale of the street space at the pedestrian level?

(3) What is the role and impact of certain socio-cultural aspects, in Saudi Arabia, on walking, which may have contributed in pushing the pedestrians outside the street space into other urban places? What are the physical and spatial characteristics of the existing urban street associated with this withdrawal?

(4) How to collect necessary data – which has not been made available before – regarding the actual pedestrians, including walking patterns, sensitive socio-cultural aspects and the upper thermal comfort limit in the outdoor urban spaces of Dammam?

(5) What design considerations are required by pedestrians to restore walking into the street space in Dammam?

Although answering some of these questions is somewhat interlaced between certain chapters, eliciting context-sensitive answers from the actual pedestrians is the most appropriate approach to provide a realistic diagnosis (Gehl & Svarre, 2013; Miles et al., 2014). Therefore, the following objectives are set to answer the above questions in order to attain the main research aim:

(1) To develop a conceptual approach to understand the factors affecting walking on streets that are most relevant to case of the Saudi context; this is partly discussed in Chapter 1 and in detail in Chapter 2;

(2) Using this conceptual approach, to understand how the decline in walking and pedestrians' behaviour on urban streets have been addressed, in the global context, as well as to gain rich insights into factors affecting pedestrians thermal comfort and how the urban microclimate can be mitigated and optimised in a hot and humid climate at the pedestrian level, which is discussed in Chapter 3;

(3) From this thorough understanding, to identify and analyse the physical and spatial characteristics of the existing street space in Dammam and how this space responds to the prevailing climate conditions and the most pertinent outdoor related socio-cultural aspects for the Saudi context which may have explanatory power to account for the pedestrians' withdrawal; this is covered in Chapter 4;

(4) By reviewing pertinent data collection methods and deciding the appropriate approach for field activity, to identify (a) the upper thermal comfort limit in Dammam; (b) the most influential socio-cultural aspects on walking; (c) the actual use and walking patterns by the actual pedestrians; and (d) the physical and spatial characteristics of the street space that do not respond to points (a),

(b) and (c), and which eventually are hindering the use of streets by pedestrians, which is reported in Chapters 5 and 6; and

(5) To draw on the findings to inform decision-making with recommendations into improved street design to restore walking into the street space in Dammam and other Saudi coastal cities, as presented in Chapter 7.

1.9 Theoretical Framework

Studies on the relationship between the urban environment and physical activity mainly "focus on just one or two dimensions [...], and these dimensions have been measured in many different ways, largely due to the lack of a guiding theory" (Handy, 2004: 15). Therefore, the following paragraphs briefly review some of the most important studies in this area.

Many sources advocate rediscovering street space as a social place encompassing people's interactions and as a connecting space – rather than separating the urban component (e.g. Appleyard, 1981; Jacobs, 1993; Hass-Klau et al., 1999; Gehl, 2001; Whyte, 2001; Carmona et al., 2010). In the same vein, others have emphasised the need to study the impact of cars and traffic on social aspects as the main source of the decline of street life (Jacobs, 1961; Rudofsky, 1969; Sennett, 1978; Appleyard, 1981; Trancik, 1986; Hass-Klau, 1990; Jacobs, 1995; Marshall, 2005; Gehl & Hook, 2010). However,

> "design is less often included in studies than land use or transportation [that] are more routinely measured [...] than behavioral theory about what aspects of land use and transportation influence physical activity behavior" (Handy, 2004: 15).

Even more specifically, some authors argue the need to tackle the decline in physical activity by adopting concepts of the 'Complete Streets' policy, i.e. designing the built environment at the microscale in relation to diverse modes of transport, users and land use activities (Handy, 2004; Salingaros, 2005; Handy, 2005; Handy et al., 2006; Gehl, 2010; Salingaros et al., 2011; Litman, 2014). More recently, Hass-Klau (2015) went further by recommending the creation of independent pedestrian footpaths coupled with traffic calming measures as a powerful policy.

Moreover, a few researchers assert the importance of exploring the socio-cultural aspects, through which behaviour such as undertaking increased physical activity is governed and guided, when studying the use of urban public spaces (e.g. Rapoport, 1991; BaHammam, 1995; Al-Abdullah, 1998; Tsao, 2007).

Furthermore, there is an increasing interest in affirming the correlation between the decline in using urban spaces, including walking, and the lack of climatically-sensitive urban design, including streets that provide conditions of outdoor thermal comfort (e.g. Nagara et al., 1996; Nikolopoulou et al., 2001; Toudert, 2005; Johansson & Emmanuel, 2006; Lin, 2007; Hwang et al., 2011; Ng & Cheng, 2012; Jaber, 2013; Setaih et al., 2013; Alznafer, 2014).

Nevertheless, Gehl and Svarre (2013) draw attention to the necessity of the amalgamation between all types of potential users and all aspects of the local context, namely, public life activities, socio-cultural qualities and environmental conditions, when studying urban spaces. In a similar context, Boussoualim (2000) recommends investigating the link between microclimate, urban morphology and user behaviour in the design of the external public space.

Clearly, there is a “lack of an agreed-upon theoretical framework [...] to date on the relationship between the built environment and physical activity” (Handy, 2005: 126). Similarly, Bauman et al. (2002) confirm that there are many significant variables associated with walking that are not related to any of the existing theories of walking behaviour. This deficiency, indeed, is not surprising in view of the multifaceted nature of the factors affecting an individual’s choice to walk. Thus, studying the cause-and-effect relationship between street design and walking is one of the primary challenges in this research.

1.9.1 Conceptual Approach

Considering the discussion above, and in order to restore walking into Saudi streets, the issue needs to be analysed within a framework that bridges the most prominent influential factors identified by the society and must be firmly grounded in the local context and conditions. That is, because street design that pursues an approach adopting a single set of design criteria to fit all contexts has proved problematic, invalid and inadequate (Abu Dhabi Urban Planning Council, 2012).

Accordingly, for the Saudi context, Al-Saud (2006) and Alznafer (2014) conclude that more attention should be given to reviewing the characteristics of urban spaces in order to overcome the resultant degradation in outdoor life. They specifically attribute the underlying cause to the lack of design interventions minimising the severity of urban microclimate conditions, whilst BaHammam (1995) and Al-Abdullah (1998) place great emphasis on taking the dominant socio-cultural attributes in Saudi into due account as the primary source that influences the final form of the built environment.

Indeed, these studies explicitly recommend adopting an innovative, context-sensitive approach, challenging the emerging urban environmentally-related consequences, as well as fulfilling the growing demand for a sustainably built environment in the KSA. On this basis, the challenge under study is addressed through an approach in which the relationship between (A) certain socio-cultural attributes, (B) pedestrians' thermal comfort conditions and (C) characteristics of urban streets on the microscale of the street space is investigated. The research postulates an interactive relationship between the existing conditions of the street space (C) and the two other factors (A and B).

Consequently, the research proposes a study model that explains the relationship between these three interrelated components, and is meant to serve as a conceptual approach, within which the research aim can be fulfilled and the question answered. Restoring walking into the street space is largely governed by these factors, and hence they need to be jointly studied, where no specific factor is more prominent in this process than the other two (Figure 1.12). Indeed, behind each component lies a theory or hypothesis that is discussed and explained in later chapters.

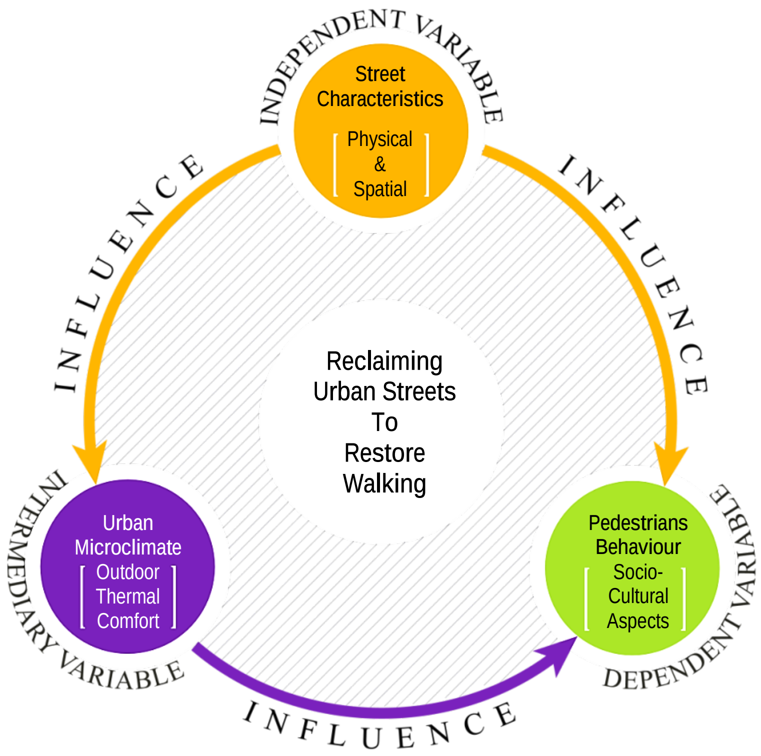


Figure 1.12 Proposed conceptual approach (Source: the author)

The model specifically demonstrates that reclaiming urban streets in Saudi Arabia to restore walking necessitates changing the existing characteristics of the street space physically and spatially – where people become the driving force in shaping this public space. These changes should be climatically-sensitive and socio-culturally responsive. Similarly, the lifestyle of walking in urban places other than the street space is a form of behaviour change, and hence changing the behaviours entails changing the context of the behaviour (Maio et al., 2007; Shaughnessy et al., 2015).

1.10 Research Methodology

The notion of a good research design is that study that identifies the factors most pertinent to the research problem and employs the most effective methods according to the nature of the phenomenon to answer the main question (Ittelson et al., 1974). That is coupled with the fact that there are no methods and methodologies which are regarded appropriate for a certain discipline (Zeisel, 1984). In this context, any researcher “should not let one’s discipline determine the choice of method; rather, one should fit the method to the problem” (Simon, 2003: 44). Similarly, there is no single ideal study that “conforms exactly to a standard methodology; each one calls for the researcher to bend the methodology to the uniqueness of the setting or case” (Miles et al., 2014: 7).

However, the process of selecting a research methodology that appropriately responds to the research problem together with data collection techniques that best answer the research question(s) often becomes a problem in itself (Al-Abdullah, 1998). Accordingly, this research adopted the strategy of the “mixed methods” (Creswell, 2015), combining ***participant observation*** with ***interviews and a questionnaire***, as a subset data collection approach of the broader “case study” method (Yin, 2014) conducted in a “field study” (Mligo, 2013).

Such a strategy was particularly important owing to the lack of previous similar studies (Liu, 2007) conducted for the Saudi context. While Dammam was the “case” that combined theoretical studies and factual materials, the mixed-method data collection was implemented *in situ* and structured on the basis of a direct interaction with the walking places and the pedestrians. Moreover, there were further justifications for collecting the required data through a field study:

(1) It was a reliable source to obtain very timely information about the available walking places and pedestrians, due to presence of the researcher in the space, physically (Hume & Mulcock, 2004; DeWalt & DeWalt, 2011);

(2) It was an “ideal laboratory” that allowed for the researcher to explore more realistically and thoroughly relevant data from the actual pedestrians, by directly interviewing and observing them, in their actual walking places (Miles et al., 2014; Yin, 2014). This is “referred to as the *emic*, or insider’s perspective” (Merriam, 1998: 7); and

(3) It was a contributing factor to gather significant evidence of “what worked and what didn’t. And such evaluation, goes a long way toward pinpointing where adjustments are deserved or preventing the duplication of mistakes in the next job” (Molnar, 2015: 25).

1.11 Scope and Limitations

Given that there are wealthier societies than Saudis still maintaining walking as a lifestyle, it is clear that the economic situation has become a less influential factor on walking, and hence was excluded from this study.

The scope of this research centred on combining an understanding of pedestrians' thermal comfort in a hot and humid urban environment, that of the city of Dammam, where the problem is particularly acute, coupled with exploration into the socio-cultural aspects through which behaviour such as undertaking increased physical activity is governed and guided.

Additionally, as this study acknowledges that the urban microclimate conditions during the summer in KSA cause thermal discomfort, the data collection activities through field studies were conducted during temperate conditions, in spring 2012. The underlying justification is to exclude the extreme weather influence in summer, so as to identify the upper thermal comfort limits of the pedestrians after which walking could be intolerable experience. In addition, this will enable the researcher to explore whether people are using streets for walking during this moderate season or other factors are involved which impact on their withdrawal.

Moreover, proceeding from the fact that there is an overall lack of pedestrians walking along streets, particularly within neighbourhoods, and the crucial need to collect data *in situ*; two strategies were employed. First, the primary data collection process through the questionnaire method was applied in all available walking places in Dammam, including two carefully selected streets with different configurations in the city centre, some walking tracks, main Corniche walkway and a shopping mall popular for walking. Second, in order to observe the actual pedestrians in the actual setting, the observation method was confined to the same two selected streets.

1.12 Original Contribution to Knowledge

Many studies have focused on the effect on people's use of outdoor spaces through creating accessible and liveable urban streets for all. Others have emphasised applying concepts of outdoor thermal comfort to the use of public spaces. And few others have underlined that walking is affected by certain socio-cultural aspects.

However, integrating these three influential factors connected to walking in a single study is an approach has not been elaborated or even attempted previously.

In general, this study contributes to the unending quest for knowledge initiated by many researchers, mainly in Europe, to improve the quality of life in outdoor urban spaces through design.

For Saudi Arabia and other countries, at least those located in the Middle East under a hot-arid climate, reclaiming urban streets for the pedestrians remains a valid area for research contribution. Specifically, this research is the first of its kind that integrates Landscape Architecture, Climatology and Environmental-Behaviour studies for the Saudi context as a holistic approach to address the phenomenon of the decline of walking rates on urban streets. This is directly attributed to the very limited number of researchers in the field of landscape architecture.

1.13 Structure of the Thesis

This thesis comprises eight chapters organised in three parts (Figure 1.13), because any landscape architecture study is recommended to undergo three stages (Steinitz, 1990). **The first part,** Chapters One to Four, provides the approach, context and background. **The second part,** Chapter Five, covers the data collection methods and their fieldwork application to answer the research questions. **The third part,** Chapters Six to Eight, presents the findings, discusses and links the findings with the literature, and summarises the overall conclusions of the research. Accordingly, a brief description of each chapter is outlined as follow:

Chapter One has outlined the context of the research, identified the purpose and supportive justifications for tackling the declining rates of walking and presented the research problems behind the decline in the street space quality for pedestrians. In addition, it has briefly highlighted the case study area, set out research questions and objectives and presented the conceptual approach and original contribution to knowledge. The research scope and limitations as well as the research methodology have also been presented in this chapter.

Chapter Two is a preliminary literature review with one particular aim, which is to justify in detail the proposed conceptual study model presented in this chapter (see

1.9.1). This chapter, while drawing heavily on observed results in a vast collection of previous studies, argues there is a need for research projects to bridge the gap into restoring walking into streets on the basis of context-sensitive approach that should differ from one culture to another.

Chapter Three sets out the theoretical background of the research by reviewing various aspects identified in the literature which are connected with two components of the proposed tripartite model. Therefore, this chapter is divided into three sections: (a) reviews the concepts, theories and issues related to reclaiming streets for pedestrians, (b) reviews the concepts of outdoor thermal comfort, including the impact of the characteristics of the urban spaces on the urban microclimate and its relation to the pedestrians' thermal comfort, and (c) reviews of the theory of spatial behaviour in the socio-cultural context.

Chapter Four is partly a further literature review focused on the Saudi built environment and partly an analysis of existing street characteristics in Dammam. Specifically, two major sections are covered in this chapter: (a) a review of the formation and transformation of the traditional built environment in Saudi with specific concentration on the case of Dammam, (b) exploration into the most sensitive socio-cultural aspects and issues for Saudis in outdoor spaces, and (c) analysis of the street space, physically and spatially, by means of first and second sources.

Chapter Five discusses the design of the field study methodology, reviews the rationales behind adopting the case study method and explains the mixed methods utilised for data collection. This chapter also outlines the collection challenges, procedures and nature of the collected data, as well as the scope and limitations. The criteria behind the selection of the case-study sites in Dammam, where the two methods for obtaining the empirical data were implemented, are also highlighted.

Chapter Six reports the primary data collected and analyses findings from the fieldwork activities; quantitatively and qualitatively. Thus it is divided into two sections: (a) Quantitative, through an original interview-based questionnaire carried out in different walking environments in Dammam. The questionnaire is structured in three parts, representing components of the tripartite model, in addition to a fourth general part; and (b) Qualitative, by applying the participant observation technique, with special emphasis on the pedestrians' walking patterns, activities and interaction with the existing conditions of the street space. This latter method is applied only in the selected streets in the city centre of Dammam.

Chapter Seven discusses and interprets the key findings in light of the theoretical studies. This serves as an approach to identifying ways in which the neglected street space can be reclaimed for walking under hot-humid climatic conditions for people with sensitive socio-cultural consideration in outdoor spaces. The chapter also presents an overall summary of the research and lessons from completing this research, as well as research areas and directions that need further studies.

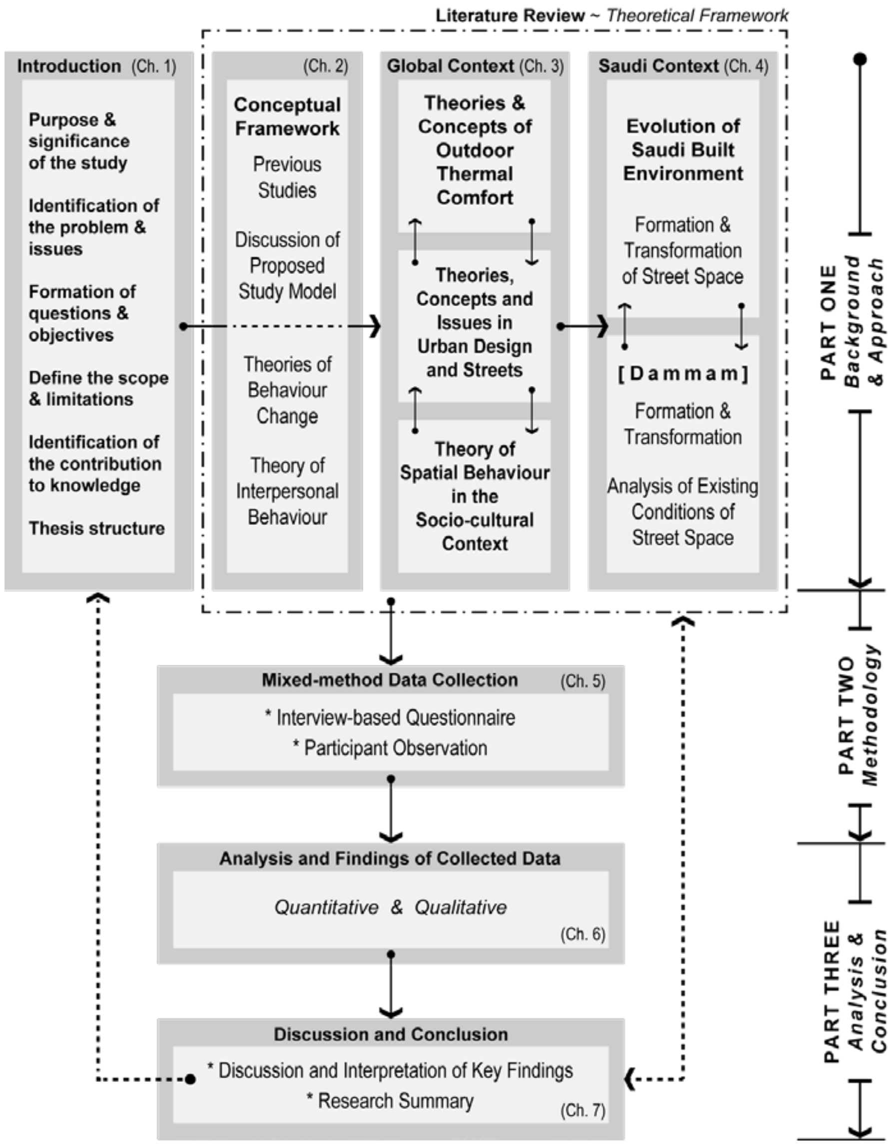


Figure 1.13 Outline of the Thesis Structure

Chapter Two: Conceptual Framework

"A conceptual framework explains, either graphically or in narrative form, the main things to be studied—the key factors, variables, or constructs—and the presumed interrelationships among them. Frameworks can be simple or elaborate, commonsensical or theory driven, descriptive or causal" (Miles et al., 2014: 20)

2.1 Introduction

This chapter is a detailed discussion and further justification for the proposed model for this study (see 1.8.1) that explains the relationship between the three interrelated components to restoring walking in the street space. These three key factors relate to one another and exhibit some sort of coherence where each is very valuable to be considered and understood. Joseph Maxwell in his foreword to Ravitch & Riggan's *Reason & Rigor: How Conceptual Frameworks Guide Research* (2016: xi-xii) refers to this assortment as:

> "something that you create from multiple sources, not something that you find ready-made in the literature and simply adopt. Existing, explicitly formulated theories can be a major source […] from which you develop your conceptual framework—and may provide the basic ideas and structure for this framework—but they rarely constitute the entire framework […] Reality is always more complex than any theory can completely capture, and you need to construct a conceptual framework that takes account of this complexity and avoids gross oversimplifications of the things you are studying, as best you can".

Therefore, the nature of this chapter is a preliminary literature review which aims to establish a holistic discussion of this study by demonstrating how this particular integration of components seems to provide the best approach for the research problem. This includes what is already known in relation to the research question, what is not yet clear, and how this thesis fits with other studies.

2.2 Previous Studies:

Practically, human beings differ in their requirements, expectations and responses, due to the wide array of factors and stimuli that play an influential role and change from one place to another. Chief among these factors are the characteristics and quality of the physical surroundings (i.e. indoor or outdoor environment), climatic patterns, dominant cultures, social situations and behaviours (Gehl, 2010). Keeping that in view, the aim of this thesis suggests ways to restore walking into the street space; hence the process of attaining this aim lies within the context of behavioural change.

Therefore, it becomes self-evident that this is an interdisciplinary research area structured around the interrelationship between pedestrians' spatial behaviour and requirements (the human dimension) and their surrounding physical environment and environmental conditions. Accordingly, one of the basic concepts that needs to be understood and clarified, as early as possible, is what is meant by environment and what is the environment under study in this research.

Indeed, in all the attempts to understand ways of transforming outdoor spaces into places[11] as well as to encourage the use of these spaces, one can find the human dimension is always the central factor. This research can be characterised, by definition, as a study of the Environment-Behaviour relationship (EB) "including environmental psychology and socio-cultural factors" (Moore et al., 1997: 2), where its aim is to "study healthy lifestyle issues and help build the evidence base necessary to develop design and management solutions" (Moore & Cosco, 2010: 40).

Hence, the central theme of this research focuses on the relationship between characteristics of the street environment and pedestrians. Thus, walking is the behaviour and activity that establishes healthy lifestyle, and street space is the container and physical environment of this behaviour, where pedestrians can and do choose to walk. In this respect, there is increasing recognition that design of any urban space, including its spatial configuration and physical components, affects outdoor behaviour, which, in turn, contributes to influence a healthy lifestyle (Aboelata et al., 2004; Moore & Cosco, 2010).

Accordingly, the urban street can be either shaped as a space or place. If a street is designed as an environment solely for facilitating movement, it is identified as a space (Trancik, 1986). If a street is defined as an "outdoor room" (Cullen, 1961: 29),

[11] "Space is transformed into place as it acquires definition and meaning" (Tuan, 1977: 136).

which accommodates various types of human activities, values, events and meanings, including socio-cultural interactions, it is acknowledged as a place (e.g. Trancik, 1986; Rapoport, 1991; Kostof, 1992; Carmona et al., 2010; Gehl, 2010; Hass-Klau, 2015). Consequently, in response to the main aim of this research, this latter approach is adopted, in which the street environment is seen as a descriptive container, because:

> "A street is a very different place to a pedestrian and to a car driver – they do not even attend to the same objects and signs and they certainly have quite different experiences and purposes – yet at different times one person may both walk and drive down that street" (Relph, 1976: 56).

This explicitly refers to the "effects of scale, speed of movement and distance" (Rapoport, 1977: 240); hence, the requirements of both street users differ. The experience per se involves movement, so it is a dynamic and sequential process, affected by speed, time and distance; thus it plays a major role in how both users interact with urban streets (Nasar, 1998; Heft & Nasar, 2000; Gehl & Svarre, 2013).

Given that pedestrians move around with low speed, they can notice and appreciate smaller scale and finer-grained qualities, including differences in forms, textures, colours, ornament and activities. Therefore, pedestrians require "noticeable differences and complexity" (Rapoport, 1977: 220) or "scale, senses and the dimensions of city space at eye level" (Gehl, 2010: 38). On the other hand, driving is not only faster than walking, but also requires much concentration and attention (Gehl, 2010), thus the quality of the surrounding environment is rarely appreciated.

Consequently, when urban streets are designed in ways prioritising motorists only (e.g. large scale and coarse-grained elements), the environment becomes deficient for pedestrians. On this basis, as pointed out earlier, street design that pursues an approach of adopting a single set of design criteria to fit all types of users, contexts and locations has proved problematic, invalid and inadequate (Abu Dhabi Urban Planning Council, 2012). In this context, Ralph Erskine (cited in Gehl, 2010: 82) asserts that:

> "If the complex is interesting and exciting at eye level, the whole area will be interesting. Therefore, try to make the edge zone[12] inviting and rich in good detail, and save your efforts on the upper floors, which have far less importance both functionally and visually".

Through reviewing the relevant literature, it becomes evident that researchers have made an effort to define the environment through its components and functions, which differ from one discipline to another. However, given that walking is a form of behaviour as much as a physical activity, the associated concepts are better understood within the environmental psychology framework that focuses on man's relationship with the environment.

According to Gibson (1966) the environment surrounds and encompasses various activities, and hence its function is as a container. Lang (1987) further identifies the environment as a system that consists of four elements, namely, 'physical', 'psychological', 'social' and 'behavioural'. While the physical environment represents the terrestrial or geographical setting, the psychological environment reflects perceptions of it which people hold in their heads. The social environment is the system that governs and guides interpersonal and inter-group interactions; the behavioural environment embraces all elements to which a person responds (Al-Said, 1992).

This last dimension becomes of particular emphasis in studying the interrelationship between the individual's internal behaviour and the external stimuli, as in the case of this thesis. Therefore, given that Landscape Architecture is among the professions mainly concerned with the design and management of outdoor spaces for outdoor users, whether in urban or rural areas, three interrelated components are significantly unavoidable if walking outdoors is the aim to attain. These are the physical space, the various types of users, including their behaviours and activities to be practised within this space, and the dominant climate conditions (thermal environmental conditions) in this space.

In this context, the 'Theory of Place' developed by Canter (1977) as the central purpose in his book *The Psychology of Place*, conceptualises similar constituents

[12] See Chapter Three (3.2.3).

(Figure 2.1) and asserts that any place is a resultant system of the interaction between "what behaviour is associated with, or is anticipated to be housed in it, what the physical parameters of the setting are, and the descriptions or conceptions which people hold of that behaviour in that physical environment" (Canter, 1977: 159).

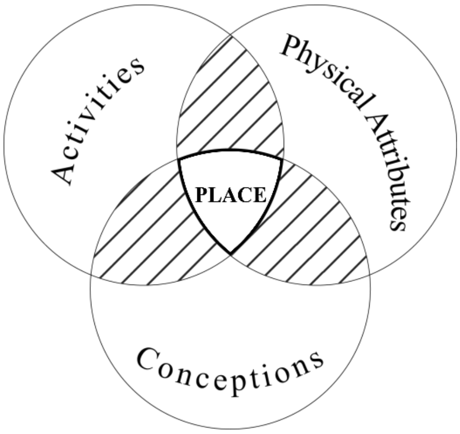


Figure 2.1 Theory of place (Source: Canter, 1977: 158)

Rapoport (1984) goes beyond the Canter's model and adds the sense of a secure place as a dimension belonging to the most basic socio-cultural needs. Nevertheless, Canter (1996) acknowledges the role of the socio-cultural attributes – which "accumulate from the interaction between people's society and their culture" (Al-Abdullah, 1998: 18-19) – as the agreed upon container and origin for behaviours. Behaviour can be classified as either *'covert'* or *'overt'*.

While the *covert* behaviour is an invisible process that occurs inside human body, the *overt* is the individual's physical response visible to others that is "the result of external and internal stimuli" (Scott, 1958, cited in Al-Said, 1992: 9). For this, Canter highlights in his model that "the significance of a place was not some reflection of the external physical parameters that characterise that place, but derives from the cultural framework within which people experience a place" (Canter, 1996: 8). He further emphasises the important role of considering "individual, social and cultural processes" (Canter, 1997: 110) in the experience of a place as an integrated system.

Hence, the individual's overt behaviour as a physical translation of the socio-cultural values becomes a major dimension in the transformation of any space to become a place. Behaviour is seen as manifestation and mechanism that reflects and satisfies human needs, whether consciously or unconsciously (Al-Said, 1992). However, people’s interaction with the space has been acknowledged to be influenced by their previous experience and background, so that the “expected and accepted behaviors and attitudes vary from culture to culture” (Lang, 1994, cited in Carmona & Tiesdell, 2007: 222).

For this reason, Altman and Chemers (1984) put further emphasis on the role of culture on shaping the environment. They argue that the physical environment is a resultant and reflected system of the interaction between (a) people, (b) their culture and (c) characteristics of the physical surrounding. They stress that all the three components are embedded in any environment and form an inseparable and integrated social entity ‘system’. Thus, it is unrealistic try to understand any component separately.

BaHammam (2006) concludes that the role of behavioural factors has a significant influence in giving the Saudi traditional built environment its own distinctive style. Behavioural factors related to architecture include a wide range of human concerns, responses and attitudes. Privacy is one of these factors and - because it is formed and influenced by the interaction of cultural and religious values and plays a strong role in the Saudi society - it has become the determining behavioural factor in shaping the Saudi built environment. BaHammam clearly demonstrates how such a required socio-cultural behaviour is translated and reflected into physical reality in many architectural spaces and forms and spatially in public actions and practices.

In a rather similar way, Moore et al. (1985) developed a model that illustrates the nature of this man-environment interrelationship. According to the model, the individual’s behaviour – that is surrounded by the social system and governed by cultural values, i.e. the ‘socio-cultural context’ – stems from inside a person and reacts physically to stimuli from the external world. They additionally emphasise that this individual’s behaviour can be a response of internal physiological and psychological processes (i.e. *covert*) towards conditions encompassed within the outer world. Opening a window or taking off a shirt is a behavioural response to the internal feeling of discomfort caused by the surrounding uncomfortable climatic ‘thermal environment’, for example.

Moreover, given the fact that the influence of climate was briefly mentioned as affecting human behaviour, its role is of central importance in this research. Nevertheless, in order to avoid for this review to be simply descriptive, it has to be noted that one aspect of which the previously mentioned researchers have not taken as a major dimension in their studies is the role of climate. Therefore, the influence of urban climatic conditions on creating places has been neglected in the above discussion. Additionally, while the theory of thermal comfort and its impact on human spatial behaviour has been intensively studied in indoor environments, recently there has been an increasing interest in emphasising its role in the use of outdoor public spaces.

A considerable amount of literatures focusing on the ‘people-climate relation’ has been conducted by several researchers in the field of environmental psychology (Westerberg et al., 2003), although “it is not until recent years some researchers have regarded climate as a dimension that is always present in the study of environment and behaviour” (Bergström, 2004: 7). The significance of taking the outdoor thermal comfort as a major component in this thesis is clearly attributed to the fact that:

> “Thermal environment of urban spaces plays a great role on the quality of life in a city. It directly affects people’s behaviour and usage of outdoor spaces. Therefore, an environmentally conscious urban design solution should give high priority to the thermal comfort implications of urban microclimate” (Sharmin et al., 2012: 57).

Jacobs (1993), in addition to understanding the role of physical factors and characteristics, highlights the role of climate in supporting outdoor social life. For good reason, Jan Gehl and others have begun realising importance of the urban microclimate and how it is significant for it to be taken into deep consideration if outdoor spaces are to be used. Gehl asserts how important microclimatic conditions are, as one determining factor for the use of outdoor urban spaces for social life and activities, because “Good weather is one of the most significant criteria for assuring the ease of people’s movement in cities” (Gehl, 2010: 168).

Most importantly, Aicha Boussoualim (2000), in an attempt to unpack the complex relationship associated with the use of external spaces, developed a method to understand ways of encouraging the use of these spaces. Relatively similarly to

Altman and Chemers (1984) and Canter (1977), Boussoualim argues that there is a crucial need to fully and carefully consider three forces and the way they blend together and form one functional system.

Specifically, Boussoualim stresses the need to study the three interrelated components: (a) the urban microclimate, (b) the outdoor user’s behaviour and (c) the morphology of the urban environment as one entity, if the aim is to encourage the use of urban spaces – a conclusion that has been recently reinforced by Gehl and Svarre (2013). While the last dimension is considered independent so that it affects the other two variables, the first affects the third, which becomes the most influenced by the other two factors.

Although it could be argued that reconfiguring the existing urban morphology may seem difficult to apply everywhere – not to mention being an unsustainable approach, Boussoualim identifies the spatial configuration ‘geometries’ of outdoor urban spaces as more “important in the microclimatic variations” (Boussoualim, 2000: 459). Thus, this component combined with urban microclimatic conditions is considered more influential on user’s behaviour toward using the space.

Accordingly, the user’s behaviour becomes more influenced by external factors than internal stimuli, and hence Boussoualim goes further by placing much emphasis on the role of streetscape components, because this latter aspect is the most exposed to and evaluated by the majority of outdoor users, as well as having a direct influence on their behaviour and activities (Boussoualim, 2000; Nikolopoulou et al., 2001; Gehl, 2010; Kott, 2011; Alznafer, 2014). In a very similar discussion context, Nikolopoulou (2004) acknowledges the significance of understanding such aspects in creating acceptable thermal conditions outdoors:

> “as this can have major implications for the development of cities. By controlling sources of discomfort, sedentary activities, as well as the use of public transport, cycling and walking are promoted” (Nikolopoulou, 2004: 101).

What is much important in this triangular relationship is the assertion by Nikolopoulou and others of the need for “understanding of the human parameter in these spaces, and their subjective responses” (Nikolopoulou et al., 2001: 228). From a relatively similar standpoint, Nicol et al. (2012) assert that it is important to understand the complexity of the interaction between these three factors to provide comfortable and usable spaces.

In order to successfully provide such spaces, their design needs to be based on a thorough and wide "understanding of the three-way interaction", that is, between the space which people will use and occupy, users of the space, including their socio-cultural aspects because "culture and preferences are partly determined by climate" (Nicol et al, 2012: 68), and the climatic conditions by which people will be directly influenced.

However, the major focus of these increasing studies, on one hand, tend to be in the form of people's presence, mainly in resting areas where people choose to sit (sedentary or static), such as urban squares, parks and sidewalk cafes, rather than thoroughfares and walking (active or dynamic). The reason is due to the fact that:

> "walking encompasses all movement, while public space attendance is a relatively small subset of walks usually with recreational or leisure content [...] attendance in a public space is mostly a voluntary activity, while walking is often necessary to accomplish some routine task" (de Montigny et al., 2012: 821).

On the other hand, in an attempt to explain why this growing interest has been extensively studied indoor, Nikolopoulou et al. (2001) attribute this "to the great complexity of the outdoor environment, in terms of variability, temporally and spatially, as well as the great range of activities people are engaged in" (Nikolopoulou et al., 2001: 228). Additionally, taking into account the length of exposure to specific environmental conditions as a pedestrian, few studies have addressed the association between walking, climate and the outdoor environment, specifically in extremely hot countries.

Moreover, in a clear recognition of the lack of studies focusing on the role and impact of climate conditions on encouraging walking, it has been noticed that one can "expect some effect of weather on walking behavior, but we know little about the amplitude or direction of the effect" (de Montigny et al., 2012: 822). For this, in an attempt to understand the link between human behaviour, use of outdoor spaces and how this association differs from one climate to another, Nikolopoulou, in several published works, asserts that the microclimatic characteristics

> "affect the activities that are carried out in the urban environment, [...] people's behaviour and usage of outdoor spaces. Responses to the microclimate may be unconscious, but they often result in a different use of open space in different climatic conditions' (Nikolopoulou, 2004: 101).

Similarly, Gehl and Svarre (2013) argue that "it is necessary to consider the context of the study holistically, including the local physical, cultural and climate aspects". He further emphasises that it is insufficient to rely on one component when addressing issues associated with outdoor life and spaces; instead, it is "necessary to combine various types of investigation" (Gehl & Svarre, 2013: 22). Focusing on the relationship between people and activities on one hand and climate on the other hand, Gehl (2010) illustrates this reciprocal interaction as:

> "If outdoor conditions make walking and recreating impossible, such as during a snowstorm, just about nothing happens. If conditions are tolerable, the extent of necessary activities grows. If conditions for being outdoors are good, people engage in many necessary activities and also an increasing number of optional ones" (Gehl, 2010: 20).

Hence, the role of designers becomes pivotal to provide proper interventions into such spaces. However, "there have been very few attempts to understand comfort conditions outside" (Nikolopoulou et al., 2001: 228), and, most importantly, there is a need to extend and shift "the observation frame from sedentary activity in public open spaces to walking in the street" (de Montigny et al., 2012: 822).

In this context, three recognised mechanisms of adaptation and acclimatisation have been identified as human responses to the qualities of the outdoor thermal environment; namely, physiological, psychological and physical (Nikolopoulou & Lykoudis, 2006). This last mechanism is of central importance in this study due to its relevance to the main research question and aim. The first two forms of adaptation, although briefly reviewed in 3.3.2, are nevertheless considered reactions lying inside the human body (covert behaviour) and thus beyond the scope of this research.

The physical method can be classified into 'reactive' and 'interactive'. In the reactive method, people adapt themselves to the conditions of their surrounding environment by making some changes at the personal level, such as adjusting types of clothing or moving to a more convenient space, as an adaptive technique towards seasonal or daily variations.

Although Nikolopoulou and Lykoudis (2006) acknowledge that adaptation through changing clothing level is very frequent and exercised equally across Europe, this raises an interest in thinking about whether such mechanisms can be observed in other cultures or not. Given that the focus of this research is centred on the Saudi context, it can be decisively stated that the Saudi national dress for both women and men makes it difficult to adopt this technique (see appendix D.2). Therefore, it is excluded from any further discussion in this thesis. Therefore, the interactive method, where physical changes and alterations are applied to the surrounding physical environment will be the approach in this thesis. The purpose of this mechanism is for obtaining long-lasting improvements that suit requirements and expectations of the pedestrians. This may take several forms, whether at the pedestrian level, such as streetscape improvements, or at larger scale, such as reconfiguring neighbourhood geometries (Alznafer, 2014).

Furthermore, this review, although may seem to have widened the context of the discussion, also demonstrates the size of the challenge to understand the influences associated with encouraging walking in outdoor spaces, which have been addressed at multiple levels. This is attributed to the fact that walking on the urban street is a complex activity, owing to the multi-sensory experience it provides to the pedestrian (Vasilikou & Nikolopoulou, 2014). For example, many studies of public life have focused on the relationship between people, their activities and the surrounding built environment, as well as creating particularly lively and liveable urban spaces accessible by all (Jacobs, 1961; Cullen, 1971; Appleyard, 1981; Alexander et al., 1987; Jacobs, 1995; Gehl & Gemzøe, 1996; Whyte, 2001; Handy, 2005; Gehl & Hook, 2010; Ward Thompson, 2013).

Others have demonstrated the influence of cars and the growing dependence upon them as one of the major factors behind the deterioration of street life and decline of non-motorised transport modes (Newman & Kenworthy, 1999; Perry, 2000; Mateo-Babiano & Ieda, 2007; Tsao, 2007). Other attempts studying outdoor thermal comfort have been carried out on the use of public spaces by pedestrians, as discussed above. Additionally, promoting outdoor walking, whether for a better quality of lifestyle or merely as a physical activity, has increasingly become a research area of interest at the beginning of the 21st century, and a considerable number of relevant studies have been conducted in different disciplines.

However, one can find "little consistency in the measures of the built environment or even the measures of walking used in the studies, making it difficult to compare their results" (Handy et al., 2006: 56). Consequently, in an attempt to review major studies in this area and the associated aspects, Handy et al. (2006) categorised these studies into two growing bodies of literature. The first group is categorised as travel behaviour research, which focuses on walking as a mode of transport, and is being discussed in the fields of geography, city planning and transport engineering. The second group categorises walking in physical activity research, through which walking is perceived as a form of physical exercise and recreation, and has been addressed in studies of public health, behavioural science and human psychology (Handy et al., 2006; Sallis et al., 2008).

What is more interesting than this classification is that Handy et al.'s study "presents new evidence on the possibility of a causal relationship between the built environment and walking behaviour", so that, when changes in properties of the built environment occur, there is a high possibility that these will lead to changes in walking rates "even after accounting for attitudes and preferences" (Handy et al., 2006: 55). Kott (2011) reached the same finding.

However, Ward Thompson (2013) acknowledges that there is a deficiency in understanding links and relationships between levels of physical activity, the role of planning and design, and attributes of outdoor spaces. Ward Thompson stresses that there is a "need for well-conceptualized models of environment-behaviour interactions" (Ward Thompson, 2013: 79). Others further acknowledge that there is a lack of agreed-upon best theories and models that provide a complete framework for understanding and assessing the link between the urban environment and physical activity and inform the factors for change in travel lifestyle so as to come up with conclusive evidence (Handy, 2005; Handy et al., 2006; Anable et al., 2006; Darnton, 2008; Stradling, 2011; Kott, 2011).

Although the discussion context above provides an important theoretical background for understanding issues pertinent to walking, there is still no clear framework of what specific attributes (e.g. physical, spatial, visual and/or all) of which contribute towards behaviour change (i.e. walking on streets). In this regard, Paul Stern (2000) emphasises that:

> "Single variable studies may demonstrate that a particular theoretical framework has explanatory power but may not contribute much to the comprehensive understanding of particular environmentally significant behaviors that is needed to change them" (Stern, 2000: 418).

Consequently, the purpose of this concise and early review is not intended to validate any theoretical model or discussion, but rather to emphasise that some models are too general for the Saudi context to rely upon so as to understand the interdependence between walking, climate and street space. This discussion sheds light on the importance of considering these interrelated factors to find ways to contribute in restoring the pedestrians into the street space.

It is particularly important to mention here that dealing with dynamic environments and active users is different, and probably much more difficult, than static environments and sedentary users. The urban street as the everyday landscape for pedestrians (Gehl, 2010) and basic container for walking is, by definition, a dynamic and, to a large extent, uncontrollable environment, in terms of the dynamic nature and variability of stimuli being experienced in this environment (Toudert, 2005). Additionally, most of the studies described above were developed for temperate climates, mainly for resting areas, i.e. 'static environments'; thus climatic conditions were rarely considered as a major determinant for walking (O'Hare, 2006).

If the street space is designed correctly, with physical and spatial aspects distributed appropriately and combined with streetscape elements correctly placed in response to the contextual conditions, then the street environment will be a vibrant, pleasant and convenient place that satisfies all users. If this space prioritises one user over others, and local context conditions are neglected, including prevailing climate and users' socio-cultural needs, then the whole environment will turn into 'a silent and gloomy place' (Alexander et al., 1977; Turner, 1996).

In practice, studying restoring the pedestrians into the street space evokes the need to cope with multiple factors by a novel approach (context-sensitive) that takes these associated dimensions into account collectively, unlike the mainstream approach that is echoed in; for example, this quotation: “in order to analyse the experience of the pedestrian in a research project, one has to focus on (one aspect of the environmental conditions or) each sense separately” (Vasilikou & Nikolopoulou, 2014: 102). This is because the walking experience is being directly affected by internal incentives and external stimuli simultaneously and consequently the pedestrian assesses this experience as a whole (Carmona et al., 2010; Hass-Klau, 2015).

Accordingly, the author derives from the discussion of Fergus Nicol and others the notion that the use of streets by pedestrians is influenced by “climatic, social, economic and cultural context and the quality of the [space]” (Nicol et al., 2012: 68). Because walking quality on streets requires comfort conditions at “physical, physiological and psychological” levels, which “vary spatially and culturally” (Sarkar, 2003: 10).

Nevertheless, in order to take this preliminary review into a closer examination of discussion rather than simply being descriptive, it is important to justify the value of approaching the issue of walking decline as proposed in the model, as well as why other factors have been neglected in relation to this, particularly the economic dimension. In a critical analysis of the literature that accepts the role of the economic situation and its interdependence with walking (e.g. Ewing & Cervero, 2001; Kott, 2011), a pilot study carried out, in this research, in Dammam in 2011 reveals the role that this dimension plays is a less influential or unreliable factor that affects walking in this study.

The reason is attributed to the fact there are wealthier societies with higher income than of that in Saudi Arabia still relying on walking as a lifestyle and thus using streets without being fully dependent on cars. Consequently, the economic factor was excluded from the focus of this research and its conceptual model, whilst the socio-cultural approach was adopted as an alternative investigative structure supported by the discussion of Rapoport (1991). Nag (1986) confirms that:

> “Decisions are not always governed by economic principles. Neither all the human activities can be explained by theories [...] Decisions are based on non-economic factors as well, which involve subjective elements in [the] man-environment relationship” (Nag, 1986: 31).

2.3 Discussion of the Proposed Study Model

Rapoport (1991), in the cultural and EB studies, emphasises that walking in streets is influenced by cultural variables, and behaviour is governed or determined by culture (BaHammam, 2006); thus walking is mainly a behavioural aspect. In this context, Zeisel (1984), in the study of man and the built environment, further argues that good research is recommended to be based on careful and sensitive consideration of the socio-cultural attributes and organisational properties of the physical context and people under study.

Likewise, the author believes that in order to ensure the successful use of any urban space, whether existing or proposed, an appropriate context-sensitive approach is required, which addresses and contributes to control over the sources responsible for causing discomfort or recognised as incompatible factors and challenges that hinder the intended use. Accordingly, this research focuses exclusively on an integrative conceptual study model structured around the tripartite relationship (see 1.8.1) of the major issues related to the decline of walking rates on streets. These three interrelated factors are meant to serve as an approach that may lead to inform lifestyle changes within which walking on urban streets, particularly in hot-humid regions, can be restored.

Although the model was theoretically shaped and derived from the gap in literature reviewed in this thesis, it is developed by the author. The model consists of (a) pedestrians' behaviour, as a physical reflection governed by certain socio-cultural aspects (BaHammam, 2006), (b) street characteristics (physical and spatial) as the major component of the daily landscape, and (c) urban microclimatic conditions that influence outdoor thermal comfort (Alznafer, 2014).

The author believes that walking is not an issue exclusively related to the built environment per se or pedestrians alone, but is about characteristics of the whole interrelated experience between the environment, including natural and man-made features, and people, including their socio-cultural attributes. Regardless of which factor affects or being affected, these components are bound in an interactive relationship, so that, if one factor is not supporting or not compatible with requirements of the other two, the entire structure becomes weakened, and subsequently, opportunities for walking may become less likely. Therefore, the model is seen as a meaningful approach to be studied if restoring walking into streets is the target to attain.

Consequently, current practices of street design in Saudi Arabia, and of course in other countries as well, need to be changed towards more balance between motorists, cyclists and pedestrians. This, indeed, echoes the thesis that “You never change anything by fighting the existing reality. To change something, build a new model that makes the existing model obsolete” (Dennis & Urry, 2009: 9). Similarly, it has been argued that “changing the behaviours entails changing the context of the behaviour” (Maio et al., 2007: 100). Consequently, the proposed model postulates a causal relationship between conditions of the street space and the other two factors. This means that in order to reclaim urban streets for walking as a form of behaviour change (i.e. using streets instead of other public spaces for walking), changing the existing street design is a fundamental necessity, where people, not merely their cars, become the driving force in shaping this urban space.

Specifically, changing the physical and spatial attributes of the street space in a way compatible to the microclimate conditions and people’s socio-cultural values is required. An individual’s choice to walk at different stages in the decision-making process is influenced by these variables and there is no specific factor that is more prominent in this process than others. The following paragraphs describe and discuss these factors in detail.

(1) Street Characteristics: represent an independent component that affects the other two variables. For this, reviewing the literature associated with this factor reveals significant concepts that can be useful to discuss, e.g. street geometries including aspect ratios of height of buildings to street width (H/W) dubbed as ***street canyon*** and street orientation.

Nevertheless, the main focus in this thesis is on aspects relevant to the landscape architecture at the pedestrian level of the street space; namely, physically and spatially. In this context, Gehl (2010) emphasises that the key solution to tackle the resultant negative implications of long focuses on urban design for only the benefit of cars and motorists is by introducing appropriate interventions at the pedestrian scale. This is more realistic to the existing conditions than adopting approaches at the scale of the urban form. Gehl argues that "At eye level the good city provides opportunities for walking, staying, meeting and expression, and that means it must provide good scale and good climate" (Gehl, 2010: 176).

Justifying the need for studying the street space at the pedestrian level in any city located in hot-humid climates, such as that of Dammam, it has been clarified that the urban configuration should be dispersed (Turner, 1996) "to allow for easy flow of wind through the spaces" (Nikolopoulou et al., 2001: 227). Thus, the H/W proportion of streets often becomes shallow. Therefore: "For shallow canyons, implementing shading strategies at street level (galleries, trees, etc.) is the only way to improve substantially the human thermal comfort" (Toudert & Mayer, 2006: 49).

Such a conception requires a local-context-sensitive approach, because the universal model has become impractical and no longer acceptable, as well as proving problematic due to "problems created by importing architectural vocabulary without adapting it for the local climate" (Nikolopoulou et al., 2001: 227). That approach is coupled with the wide variety of requirements and imperatives that differ from one culture to another: "Studies must be made from region to region to determine the climate factors that influence comfort and outdoor stays in cities […] microclimate at eye level must be as optimal as possible" (Gehl, 2010: 174-175).

(2) Microclimate Conditions: are regarded as an intermediate factor that is largely affected by the local climate, urban morphology and street configuration, but also affects users' behaviour. In this discussion context and similarly to Gehl's approach, Nikolopoulou stresses that studies for assessing outdoor thermal comfort and its association with the physical environment need to be undertaken "at the intermediate scale of the urban block (a scale which has received little attention in research)" (Nikolopoulou, 2004: 117). This is important as it is considered a more practical approach to test the satisfaction of outdoor users and their perceptions towards success or failure of any particular urban space to provide its users with thermal comfort.

(3) Pedestrian Behaviour: is a resultant causal relationship of the influence of both street characteristics and microclimate conditions. It has two interconnected facets in relation to the main aim of this thesis: **(a) behavioural change,** in terms of restoring pedestrians into using the street space, instead of driving to other urban spaces to perform walking, and **(b) spatial behaviour,** in relation to conditions of the street space. While the latter will be discussed in Chapter Three due to its relevance at that point, the first theory is discussed in the following paragraphs.

2.4 Theories of Behaviour Change

According to Bauman et al. (2002), there are many significant variables associated with walking that are not related to any of the existing theories of walking behaviour. Therefore, drawing on the primary aim of this research, which is to restore the pedestrians into the street space, it would be more appropriate to examine a theory of behaviour change to understand methods for facilitating lifestyle change (Maio et al., 2007). Indeed, when the challenge is to make people behave differently, it is not enough to understand why a particular behaviour occurs in the way that it is performed (i.e. walking in other urban places than streets) (Darnton, 2008b; Aspinall, 2010). Thus, it becomes more important to review theories of behaviour change rather than theories of behaviour that describe why certain behaviours happen instead of how to change that behaviour.

Accordingly, two common theories of behaviour change were found to be adopted in previous studies associated with travel behaviour, decisions and even in relation to the built environment (e.g. Handy, 2005). These are: (a) ***Theory of Reasoned Action*** (TRA) proposed by Fishbein & Ajzen (1975) and (b) ***Theory of Planned Behaviour*** (TPB) proposed by Ajzen (1991). Basically, these models focus on the individual's intention, beliefs, attitudes and social norms as the underlying determinants (Darnton, 2008a) that have a predictive power, leading to the performance of a specific behaviour if the particular behaviour is under "volitional control" (Maio et al., 2007).

Moreover, a third theory was found more informative to the context of this thesis, namely, the ***Theory of Interpersonal Behaviour*** (TIB) put forward by Triandis (1977). Although, it is a social-psychological theory which aims to study interpersonal relationships, it was found useful in the context of this research.

However, the TIB, compared to the other two theories, has been less adopted, particularly when dealing with EB studies. Nevertheless, when it is used; "it appears to have additional explanatory value over Ajzen's models" (Jackson, 2005: 95). For example, Bamberg & Schmidt (2003) in a comparative study between the TIB, TPB and Norm Activation Theory by Schwartz (1977), to measure the predictive power of each theory in the context of students' car use for university routes, found the TIB is more significant explanatory model.

What distinguishes this theory from other theories of behaviour change is the way it includes habits. This factor is of particular importance to the core of the study at hand, because pedestrians have become accustomed to walk in other places. For the TIB, intention and habit represent separate paths to the behavioural outcome such as walking (Figure 2.2). Thus, habit can by-pass intention to determine behaviour directly (Darnton, 2008b), for example, where pedestrians would actually walk.

To exemplify this relation, when walking in other urban places instead of streets becomes the habitual behaviour or accustomed lifestyle, the habit affects or overwhelms an individual's choice for walking. Therefore, the intention of that person to walk on the street declines especially when the street space has become deficient to fulfil the pedestrians' needs.

2.4.1 Theory of Interpersonal Behaviour 'TIB' (Triandis, 1977)

Fundamentally, this theory is based on the notion that any human behaviour is a result of three factors: (a) intention, (b) habit and (c) facilitating conditions "as proximal predictors of behaviour" (Karatasou et al., 2014: 141). The individual's intention is itself a result of three influential factors: (a) attitudes, (b) social factors and (c) emotions. The following paragraphs explain the TIB and each component within the framework of walking as behaviour.

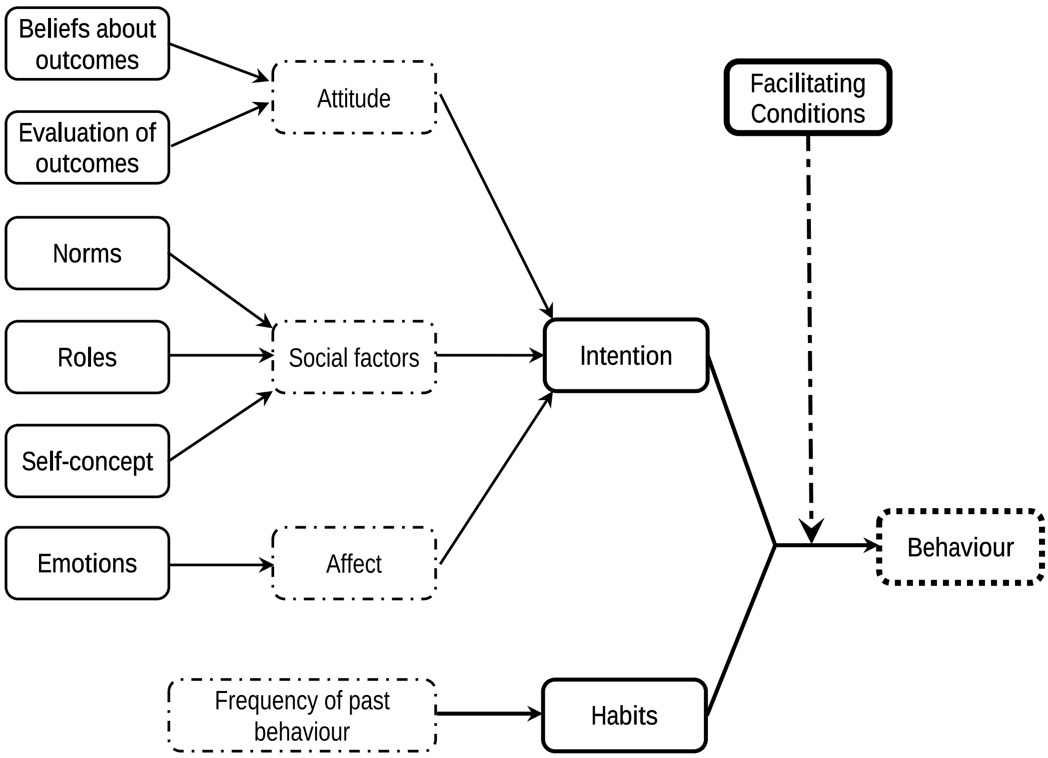


Figure 2.2 Triandis' Theory of Interpersonal Behaviour 'TIB' (Source: Jackson, 2005: 94)

The pedestrian's attitude towards walking, in general, is influenced by his/her beliefs and evaluation of outcomes and benefits to be gained by walking. The social factors consist of norms; roles and self-concept, all of which reflect the socio-cultural context (see 3.4.2), i.e. how pedestrians view themselves when walking and how they feel the society views them. Emotions are influenced by pedestrians' values and mood at the time of their decision to walk.

Habit or routine is a distinct type of causal variable (Stern, 2000) that represents the repetitive pattern of behaviour (i.e. frequency of walking inside or outside the street space). It is considered an automatic (Karatasou et al., 2014) or programmed factor in the subconscious mind (Lipton, 2015), and influenced by past behaviour (Triandis, 1977). Triandis (1980) defines habit as:

> "situation-behaviour sequences that are or have become automatic, so that they occur without self-instruction. The individual is usually not 'conscious' of these sequences" (Triandis, 1980, cited in Bamberg & Schmidt, 2003: 268).

According to the TIB, while the culture of the society, combined with personal and emotional influences, plays a key role in forming the pedestrian's intention to walk, past experiences significantly guide the actual walking at the time of decision-making. On this basis, the intention of a pedestrian to walk on a street is the immediate antecedent of behaviour; but, crucially, habit mediates the occurrence of the actual walking. However, these influences can be largely moderated by what facilitating conditions are available to that pedestrian.

Facilitating conditions refer to difficulties or advantages for walking on streets, as perceived by pedestrians, which could be socio-cultural, physical and spatial, environmental or economic. The presence of or lack of facilitating conditions can support or hinder behavioural change (Triandis, 1977; Stern, 2000; Bamberg & Schmidt, 2003; Jackson, 2005; Maio et al., 2007; Darnton, 2008a; Karatasou et al., 2014). For instance, without an overhead canopy to protect pedestrians from solar radiation, walking will be an intolerable experience. Similarly, without pavements; a safe and convenient walking will be difficult, putting the pedestrians in hazard.

Nevertheless, believing that individuals' preferences and attitudes do not remain constant (Darnton, 2008b) and change cannot be imposed, pedestrians must always be part of the decision-making process for street design. Changing pedestrians' habitual behaviour, namely, restoring walking into the street space, is in need of adequate design interventions or external facilitating conditions.

These interventions should be constructed in a way compatible to pedestrians' socio-cultural aspects, preferences and comfort, in order to alleviate their 'resistance to change' as well as to attract them back into the street space. Supporting this approach, Stern (2000) requires that interventions should always address the conditions beyond the individual and psychological factors. Similarly, Darnton emphasises that:

> "The interventions themselves should […] be developed based on past experience of what works, and be worked out on the ground, through research and piloting with the audience groups in question. […] behaviour change is best pursued as a craft not a science" (Darnton, 2008b: 69).

Therefore, the physical and spatial interventions, as facilitating conditions for walking, can account for changing current pedestrians' behaviour. This explicitly means changing the existing street design is crucial to produce behaviour change (Glanz & Rimer, 2005; Darnton, 2008a; Kurose et al., 2009; Zacharias, 2009; Gehl, 2010; Hass-Klau, 2015).

Moreover, the decision to be made by a pedestrian whether to walk on the street (as a necessary activity and lifestyle) or drive to other urban places to practise walking (as an optional activity) depends on how the available choices (e.g. pavements, walking tracks, Corniche walkways) are presented to that person, and to what extent these alternatives are capable of fostering one lifestyle over the other. This explicitly means that quality of street space; physically and spatially, is an influential determinant in the decision-making process.

For most purposes, individuals' preferences for lifestyle choices are assumed to follow the principle of utility maximisation, which can be best thought of as levels of satisfaction, comfort or personal benefit. However, pedestrians are not "walking calculators" for utility most of the time, and thus the influence of habit arises (Darnton, 2008a: 6).

Urry (2011), in relation to sustainable mobility and cultural effect, emphasises that the individual's habit often becomes affected by the influential system surrounding that person, i.e. the physical and socio-cultural environments. Similarly, Bruce Lipton (2015) argues that habit is a powerful factor that controls human behaviour, and he points out that the human brain is divided into two sections: the ***conscious mind*** and ***subconscious mind*** "autopilot". Lipton explains that:

> "the subconscious mind is primarily a repository of stimulus-response tapes derived from instincts and learned experiences. The subconscious mind is strictly habitual; it will play the same behavioral responses to life's signals over and over again" (Lipton, 2015: 121).

Nevertheless, Lipton emphasises that habit can be changed. Habitual behaviour often takes over when the conscious mind is not observing changes that attract an individual's attention, and hence comes the role of the facilitating conditions (e.g. environmental stimuli) in the TIB to alter the current behaviour. Behaviour change "often requires breaking old habits and becomes established by creating new ones" (Stern, 2000: 417). Similarly, "the observing conscious mind can step in, stop the behavior and create a new response" (Lipton, 2015: 178).

To reach this level, new criteria and considerations for street design are fundamental to make the current practises of pedestrians untenable or ineffective, which may thus eventually lead the pedestrians to deliberate on their current lifestyle towards developing a new one. Nevertheless, this cannot occur unless appropriate design incentives which tackle the existing failure in the street space are implemented in the first place, so as to make the pedestrians aware that such incentives are available (Stern, 2000; Bauman et al., 2002; Jackson, 2005; Glanz & Rimer, 2005; Maio et al., 2007; Kurose et al., 2009; Karatasou et al., 2014; Lipton, 2015).

Moreover, the TIB is employed in this thesis in the context of measuring and predicting lifestyle change, as a partial response to the research aim and question. The purpose is to explore whether the actual pedestrians habitually prefer walking outside the street environment, for example, due to socio-cultural considerations, or are latently unsatisfied with the current street conditions that have imposed their withdrawal to designated places for walking.

The TIB will also identify pedestrians' desire and willingness (intention), in the first place, to return into the street space. This desire is very important, without which any attempt to restore walking into the street space would be unrealistic and unreflective of the culture of pedestrians in Saudi Arabia.

2.5 Summary

This chapter has answered the first sub-question posed by this research. The urban street as the daily pedestrian landscape is a very different place from the motorists' perspective. Thus, quite different experiences and requirements for the pedestrians should be taken into consideration as early as possible in the design process if restoring walking into the street space is the aim to attain.

Studying urban streets requires exploration of a diverse set of pertinent factors that are context-sensitive. Similarly, a diversity of research methods and approaches is needed to conduct research about streets. That is because all of the studies reviewed in this chapter have explicitly or implicitly relied upon certain theoretical assumptions and foundations in conducting their empirical investigations. In addition, the issue of reclaiming urban streets has been more extensively studied in temperate climates.

On the other hand, until now, a holistic theoretical framework for research into restoring walking into the street space as a better quality of lifestyle has not been specifically elaborated, owing to the multifaceted nature of the factors affecting an individual's choice to walk. Consequently, studying the cause-and-effect relationship between street design and walking is challenging and should be locally context-sensitive, particularly when the existing practises of street design combined with environmental conditions represent discouraging factors towards walking.

In summary, drawing on the TIB it can be hypothesised that pedestrians' current lifestyle is partly formed by their intention to walk and partly of their habitual response to drive to other places. Nevertheless, pedestrians are "neither fully deliberative […] nor fully automatic", and their lifestyle is "neither fully autonomous nor entirely social" (Jackson, 2005: 95). Therefore, Chapter 3 will review the relevant literature to understanding impact of the surrounding context, specifically, environmental and physical conditions as well as culture of the society, as a key factor to moderate pedestrians' lifestyle change.

Chapter Three: Literature Review

"The literature review is the most effective way of becoming familiar not only with previous findings but also with the research methodology used in previous research"

(Onwuegbuzie & Frels, 2016: 8)

3.1 Introduction

Drawing on the discussion in Chapter Two, this chapter is divided into three main sections, but interdependent and interrelated. Although each section could be organised into a separate chapter, it is more meaningful and informative to produce a precise literature review that is coherently linked. This chapter responds to objective (2) in Section 1.8 of Chapter One, which is:

> Using the conceptual approach, to understand how the decline in walking and pedestrians' behaviour on urban streets have been addressed, in the global context, as well as to gain rich insights into factors affecting pedestrians thermal comfort and how the urban microclimate can be mitigated and optimised in a hot and humid climate at the pedestrian level.

It is worth mentioning that definitions of the main concepts and terms used are clarified within the context of each section in this chapter, to reduce possibilities of misunderstanding. Additionally, according to the proposed model (1.9.1) where the street characteristics are defined independently from the other two components, it would be logical for this factor to be reviewed and discussed first.

3.2 PART ONE: Reclaiming Urban Streets for Walking and Restoring the Pedestrians

3.2.1 Overview

This section discusses walking and issues pertinent to pedestrians in the context of urban streets. This approach, although it has been thoroughly studied for European and North American countries, is nevertheless an expanding research field and remains unaddressed for many developing societies. There is mounting evidence to advocate rediscovering this public space not only as a connecting and dividing element in the city, but also as an everyday pedestrian landscape (Gehl, 2010; Hass-Klau, 2015).

As humans' needs change and evolve over time, and as behaviours change to adapt to the new situation, there is a need for urban streets to change as well. Some regions around the world, which used to be car-dependent in the near past, are constantly changing their streets to meet new circumstances. In Edinburgh, for example, the concept of "shared space" has been widely utilized: statistics show that 50% of the population travel to work by private cars and 50% by buses. Accordingly, the decision was made to redistribute the street space, or "rightsizing streets" in the same proportions: half for the bus and half for the private car (Hazel, 2003). In the same context, the author, during his study years in Edinburgh, has increasingly noticed a further action towards redistributing the street space to accommodate other types of users, specifically, pedestrians and bicyclists. This reflects a clear case of the flexibility that should be always on the priority list of street designers, and hence street space should not be fixed over years. This is also considered equitable, as it echoes identity, priority, rights, better quality of outdoor life, and is not 'anti-car'.

Moreover, although the patterns of public spaces have varied in the course of history as well as from one location to another, they have always functioned as places for social interactions, commercial activities, traffic routes and even religious events. Nevertheless, streets have always been the most vibrant public spaces for the residents to carry on their daily life in and through their towns (Hass-Klau et al., 1999). Reviewing the literature reveals a complete harmony between streets and the various human activities that take place along their sides.

Old civilisations; from the Assyrians of Mesopotamia to the Egyptians, planned their settlements to include streets as major outdoor public spaces. Romans street layout was structured on a wide street space crossing at right angles, with emphasis on marketplaces located at the intersections. Main outdoor spaces, such as squares, evolved from a linear open space along main traffic thoroughfares (Pregill & Volkman, 1993). In the medieval period throughout Europe and the Middle East, streets were designed primarily for pedestrians. They were narrow, irregular and often changed shape, with sometimes sudden right-angle or even Y- and U-shaped turns. The compactness of the street space made outdoor activities more comfortable and climate-responsive. For example, narrow streets, arcades and overhead canopies provide protection for pedestrians, primarily from the solar radiation (BaHammam, 2009; Alznafer, 2014).

Streets remained the daily landscape for pedestrians until the 19th century when the concept of boulevards and wide streets were introduced. The boulevard became the one of the glorified symbols of urban life in the second half of the 19th century in Europe (Hass-Klau et al., 1999). The design of the boulevard contrasted with the medieval streets; it diminished the narrow space that characterised ancient cities, greatly widened the street space for movement of vehicles, and compressed pavements for pedestrians. Such a transformation of the urban environment imposed several problems for pedestrians as they use the same space with cars (e.g. Tibbalds, 1992; Hass-Klau et al., 1999; Hass-Klau, 2015; Saliba, 2015).

3.2.2 Streets, Cars and Pedestrians

The interest in studying this relationship can be traced back to the early 1960's (e.g. Jacobs, 1961; Rudofsky, 1969; Sennett, 1977; Appleyard, 1981; Alexander, 1987; Hass-Klau, 1990; Moudon, 1991; Francis, 1991; Rapoport, 1991; Jacobs, 1993; Hass-Klau et al., 1999). However, the 21st century has witnessed a growing interest addressing the significance of this relation (e.g. Whyte, 2001; Crawford, 2002; Carmona et al., 2010; Gehl, 2010; McCann, 2013; Schlossberg et al., 2013; Dover & Massengale, 2014; Litman, 2014; Hass-Klau, 2015). Why have streets been receiving this much of attention, and what do they really represent to urban dwellers?

Classically, the urban street is the container and even the frontal space, just as in the case of a house; it is the front yard, the main facade and the access to the heart of a city. Thus, the street should be "illuminated" because it is the spatial entity being seen and used by almost everyone on a daily basis (Tuan, 1977). Jane Jacobs clearly emphasises that:

> "Streets and their sidewalks, the main public places of a city, are its most vital organs. Think of a city and what comes to mind? Its streets. If a city's streets look interesting, the city looks interesting; if they look dull, the city looks dull" (Jacobs, 1961: 29).

The urban street is the public place that provides the setting for the daily life and activities of the city and its users (Gibbons & Oberholzer, 1991), and even more clearly:

> "speaks a universal language: Its signals are part of everyday learning; its rules for movement are among the most widely understood of all public codes of conduct; and even its most bizarre variations offer, upon close examination, familiar goings-on" (Clay, 1987: 157).

At the end of the 19^{th} century, almost all streets around the world were dominated by walking and pedestrians, so that moving from one place to another was accomplished with simplicity and convergence of living (Hass-Klau, 1990). This was not so for long, owing to the transformations imposed by the technical revolution in transport, as the car emerged at the beginning of the 20^{th} century. Conflicts occurred between the weaker street users (pedestrians and cyclists), on one hand, and the new urban fabric and cars, on the other hand (Hass-Klau, 2015).

City patterns and layouts have changed rapidly and dramatically, where street design has experienced the dominance of private cars and suffered from their adverse effects. The movement of cars has taken a larger share of priority in street characteristics, and thus roads for vehicles overwhelmed the pedestrians' landscape, movement and activities (Gehl, 2010). Cities have become crowded by modern means of transport, people have become less dependent on self-effort for movement, local lifestyles have been replaced by a universal culture, and pedestrians have become deprived of convenient use of street space.

Simply, pedestrians were pushed to the outer side of the street space whilst the core of the street was reserved for or dedicated to the car. The cause and effect relationship between the two has accelerated and risen to prominence in the last two decades of the 20^{th} century (Tsao, 2007). This, indeed, recalls Jane Jacobs's argument that the:

> "relationship between cities and automobiles represents, in short, one of those jokes that history sometimes plays on progress. [...] automobiles are hardly inherent destroyers of cities [...] The conflicts between pedestrians and vehicles on city streets arise mainly from overwhelming numbers of vehicles, to which all but the most minimum pedestrian needs are gradually and steadily sacrificed" (Jacobs, 1961: 343-346).

In fact, the way in which street design favours cars has failed to protect the pedestrians "from the impacts of cars and the creation of areas that, while accessible by cars, are pedestrian-dominant" (Carmona et al., 2010: 80). Correspondingly, pavements as dedicated spaces for pedestrians have either been given completely to the car or are still undergoing the processes of serious compression and deterioration. Pedestrians have eventually become the everyday victim who suffers from this constant neglect, so that walking has become a challenging experience on streets (Hass-Klau, 2015). This contradicts with the **"Declaration of Pedestrian Rights"** by ***Mission Pedestrians*** that states:

> "All people are pedestrians, and as pedestrians are endowed with certain inalienable rights. Among these rights are life, liberty and the pursuit of happiness. All too often, people must risk their lives to walk. All too often, people are not at liberty to travel outside the confinement of a motor vehicle. All too often, barren streets allow one to walk, but produce no joy or happiness from the experience" (cited in Blomley, 2011: 54).

Pragmatically, any contemporary discussion about the decline of walking rates in urban spaces is inseparable from the increased growth of cars, the growing culture of car-dependent societies and the resultant adverse effects. Streets have become deficient to retain much or any user-friendliness for walking or for sustaining street life (Carmona et al., 2010; Gehl & Svarre, 2013; Hass-Klau, 2015). On this basis, it has been already acknowledged that "Not TV or illegal drugs but the automobile has been the chief destroyer of […] communities. Highways and roads obliterate the places they are supposed to serve" (Jacobs, 2004: 37).

Rachel Kyte[13] (2014) further points out that "in developing countries, people display their improved financial status through buying personal cars. In these societies [any alternative] is viewed as an option for people who cannot afford buying a personal vehicle". Nevertheless, some optimistic researchers believe there will be an end of this dependence and thus city design is transforming to be more pedestrian-oriented (e.g. Dennis & Urry, 2009; Newman & Kenworthy, 2015).

[13] The World Bank vice president for the Sustainable Development Network in 2013, now the World Bank Group vice president and special envoy for climate change.

For this, one can notice there are increasingly sincere efforts and movements that have emerged to promote alternatives, as well as to rediscover the street space as a public container for all types of users. Among these have emerged the concepts of *Complete Streets* and *Context Sensitive Street Design* that are reviewed below. These developments echo Kostof's statement that "the only legitimacy of the street is as public space. Without it there is no city" (Kostof, 1992:194), and this legitimacy means "the street acquires major significance; the city is born in a fixed place but the street gives it life" (Rossi, 1984: 51).

3.2.3 Complete Streets

Hartmut Topp (1989) argues that "reduction of the visual width of a street through narrowing the carriageway, extending the sidewalks, installation of bicycle lanes, [and] planting of trees in the parking strips" not only reduces car speeds and separates bicycle from vehicles traffic, but also produces "more justice in the division of the street area" (Topp, 1989: 299). Laplante and McCann (2008) define the complete street as "a road that is designed to be safe for drivers; bicyclists; transit vehicles and users; and pedestrians of all ages and abilities" (Laplante & McCann, 2008: 24).

However, a complete street requires "more than simple allocation of street space [and] selecting a design speed that is appropriate to the actual street typology and location" (Laplante & McCann, 2008: 26). In this context, according to Kott (2011), the effects of slower prevailing car speeds on travel time are minimal, so that "Reducing the speed of a five-mile (8 km) trip along an arterial corridor at 45 mph (70 km/hr) to 30 mph (50 km/hr) only adds 2.5 minutes, while increasing both safety and city livability" (Kott, 2011: 70). Similarly, Topp (1989) showed that reducing car speed would also reduce street noise levels and the incidence of injuries and fatalities among pedestrians. For example, lowering vehicle speeds from 65-70km/h to 50km/h would result in a noise reduction roughly equivalent to that caused by "halving the traffic volume".

Litman (2014) asserts the complete street policies should be the default mode for street designers, otherwise, justifications must be provided. While design features for complete streets may vary depending on street context, a complete street policy is aimed at producing roads that are safe and convenient for all users. Laplante (2007) further argues that conversion of a four-lane street with two lanes in each direction into three lanes with one travel lane for each direction and a centre-left turn lane improves street safety.

Another complete street measure is the raised centre median, which "visually narrows the roadway and provides median refuge for mid-block (pedestrian) crossings" (Laplante, 2007: 6). Moreover, adding kerb bulb-outs at intersections and mid-block crossings reduces pedestrians' crossing distance and improves their safety. Table 3-1 illustrates the key design features of complete streets policies.

Table 3-1 Design criteria of complete streets (Source: Laplante, 2007: 27)

Related to the pavement/pedestrian zone	Related to the vehicles zone
Kerb bulb-outs at pedestrian crossings	Narrowed travel lanes
Parkway landscaping between curb and pavement	Bicycle lanes
Retained kerbside parking	Raised medians
Countdown signals at pedestrian crossings	Reduced number of through travel lanes
Accessible crossing signals	Tightened intersection turning radii
Increased crossing signal time	

3.2.4 Context Sensitive Street Design

Ewing (2002) states that context sensitivity in street design implies "tailoring designs to adjacent land uses" and exercising "flexibility in choosing design values that better fit the context" (Ewing, 2002: 52). The idea that the urban street has a context has become an increasingly important criterion of street design practices. Topp (1989) calls for "compensatory measures", including "improving the streetscape by planting of trees and reducing the speeds" as well as installing "traffic islands and center strips" on busy main thoroughfares (Topp, 1989: 299).

Such measures make streets safer for both pedestrians and cyclists, reduce stress among street users; make the street appear friendlier, more pleasant and improve the climate (Topp, 1989). Gehl (2010) stresses that pedestrians create liveability in urban spaces or "pedestrians produce urbanity" (Topp, 1989: 299), and this quality can be obtained by creating a safer and more comfortable environment on urban streets for pedestrians (Hass-Klau, 2015).

Moreover, Ewing (2002) points out that as streets have “mixed functions” and are “not just channels for vehicular movement, but places in their own right” they require convenient accommodation for pedestrians, as well as “serious consideration of street aesthetics and a degree of traffic calming” (Ewing, 2002: 52). Table 3-2 shows the suggested design interventions for main streets.

Table 3-2 Design considerations for main streets (Source: Ewing, 2004: 54)

Related to the pavement/pedestrian zone	Related to the vehicles zone
Kerb bulb-outs at pedestrian crossings	Design speeds as low as 50 km/h
Minimum clear space from kerb: 0.5 m (1m near intersections)	Travel lanes of 3-3.4m wide
Mid-block crosswalks	On-street parking
wide pavement: 3.7m (preferred) and 2.4m (required)	corner radii of 3-4.5m
vertical kerbs	Raised pedestrian refuge islands

Kott (2011) asserts that street design which is insensitive to its context may be driven by a focus on the needs of drivers, and states that:

> “What makes streets difficult to cross and unpleasant to walk along […] is the presence of multiple travel lanes, plus exclusive turn lanes at intersections. Multilaning of streets is not prompted by geometric standards, but instead by performance standards and driver convenience” (Kott, 2011: 74).

Similarly, street widening for vehicular traffic is often prompted by the need to ease the increasing rates of congestion so as to fulfil drivers’ requirements that “put a premium on reducing vehicular travel delay, regardless of the impacts on adjacent land uses” (Kott, 2011: 74). Ewing also observed that “instead of gracious boulevards, avenues and shopping streets, America’s urban areas are crisscrossed by arterials and collectors that move traffic but have no power to move men’s souls” (Ewing, 2001: 4). Kott (2011), citing Daisa (2006) about the guidelines for context sensitive street design, highlights that urban streets are:

> “thoroughfares, multifunctional in nature, and are designed to integrate with and serve the functions of the adjacent land uses. Design criteria need to be applied flexibly in these environments, depending on key design controls, including location, functional class” (Kott, 2011: 74-75).

This explicitly demonstrates that information and conditions of the local context, which differ from one place to another, are fundamental to ensure the successful use of urban streets, and thus needs to be made available as early as possible in the design process. The context-sensitive approach in street design represents a paradigm shift in thinking for designers to design the street space as a multifunctional environment, not merely for accommodating the growth in traffic.

Moreover, according to the ***Recommended Practice (Design Walkable Urban Thoroughfares: A Context Sensitive Approach)*** of the Institute of Transportation Engineers (ITE) published in 2010, there are four roadside/ pavement zones in the street space that should be considered carefully in the design process (Figure 3.1). These are (1) **edge zone**, (2) **furnishings zone**, (3) **throughway zone** and (4) **frontage zone** (ITE, 2010: 115). Although dimensions or standards of these zones differ from one country to another (see section 4.4.5 in Chapter Four), each zone has its own characteristics that function the same everywhere as described below.

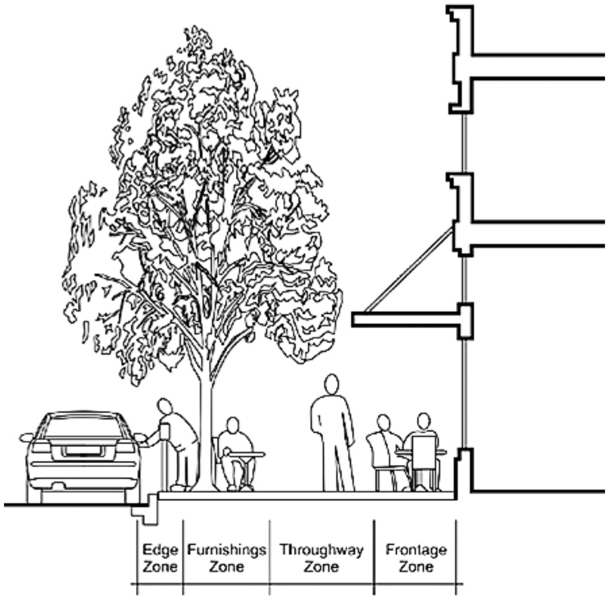


Figure 3.1 Pavement zones (Source: ITE, 2010: 116)

(1) Edge zone: is the area between the face of kerb and the furnishing zone that provides the minimum necessary separation between objects and activities in the pavement space and vehicles in the travelled way;

(2) Furnishings zone: is that area of the pavement that provides a buffer between pedestrians and vehicles, which contains streetscape elements including trees, street furniture, bus shelters, signage, light fixtures and utility poles. Anything located within this zone should not interfere with the pedestrian throughway;

(3) Throughway zone: is the main walking zone of pedestrians that must remain clear; horizontally and vertically, with minimum width considerations varying by street type; ground floor land use, availability or lack of on-street parking, and speed and volume of vehicular traffic;

(4) Frontage zone: is the distance between the throughway and the building frontages or private property line that is used to buffer pedestrians from window shoppers, appurtenances and doorways. It contains private street furniture, private signage, merchandise displays and so forth and can also be used for street cafes. This zone is often referred to as the "shy" zone.

3.2.5 Land Use, Walking and the Urban Environment

In evaluating the link between travel behaviour of individuals and characteristics of the urban environment, Ewing (2005) concludes that "walking varies as much with the degree of land use mixing as with local densities" (Ewing, 2005: 72). Similarly, Kott (2011) confirms that the relationship between density and travel behaviour is "unresolved due to the probable co-variance of density with other factors" (Kott, 2011: 80).

Ewing and Cervero (2001: 82) indicate that walking depends equally on the degree of land use mixing and densities of local land use, so that "a pedestrian-friendly environment is not exactly the same as a transit-friendly environment". The same two authors (ibid. 2010: 265), in studying the relationship between travel and the urban environment, found that the distance to local services was a key attribute of the urban environment. Although they conclude that the elasticity of travel mode in relation to the urban environment was comparatively weak, the "combined effect on travel behaviour of several urban environment variables can be substantial".

They also conclude with regard to travel mode choice that "there has been far more research in land use patterns and their impact than on other features of the urban environment" where household and socio-economic characteristics were found (i.e. in the reviewed studies) to be more important than qualities of the urban environment (Ewing & Cervero, 2001: 89). In this context, Handy et al. (2002) consider several intertwined aspects of the urban environment as important in affecting walking: (a) land use density and intensity; (b) land use mix; (c) street connectivity; (d) street scale; and (e) aesthetic qualities and regional structure.

Handy argues the urban environment comprises “urban design, land use, and the transportation system”, so that “high connectivity, human-scale streets, and desirable aesthetic qualities” are seen as making walking more viable and appealing. Nevertheless, there had been little empirical work to that date on the relationship between these characteristics and pedestrian behaviour (Handy et al., 2002: 65-66). They further argue there is a need for qualitative research methods in order “to identify the characteristics of the urban environment that should be measured and to explore appropriate ways of measuring them [such as] data on walking behavior must be spatially matched to detailed data on the urban environment” (Handy et al., 2002: 72).

The relationship between people and the environment is complex and has many interrelated facets because “people do not tend to think of the physical environment as a separate entity from the social or economic environment, nor separate from the actions they take or the perceptions they hold” (Bell, 2013: 683). In a similar context, Crane (2000) acknowledges that travel behaviour is a complex issue, therefore becomes difficult to explain the role of individual features of the urban environment in isolation from the users’ behaviour.

According to Kott’s (2011) review, “the scholarly literature lacks a detailed, comprehensive study at the level of the street and its environs of the relationship between the many aspects of the urban environment and street use”. He further adds that: “There is no clear consensus on the influence of urban environment variables on travel behaviour or even on a definition of the urban environment. The nature of the relationship seems to be contingent on the spatial scale at which research takes place” (Kott, 2011: 85).

This latter point, indeed, reaffirms that streets are context-sensitive and should be designed on this basis, which conforms to the approach undertaken in this thesis. Also, this study partly answers Handy’s call for qualitative and quantitative analysis at the scale of the street space, where the physical and spatial characteristics are most likely to influence pedestrian behaviour (Gehl, 2010).

3.2.6 Effects of Street Trees

Nature is an essential quality of the street context, and people are by nature tree lovers (BaHammam, 2004). According to Ulrich (1986), although Americans and Europeans have a strong preference for views of the natural landscape over urban views, appreciation for urban scenes tended to increase when trees and other vegetation are present. He concludes that scenes with trees typically elicit more positive responses than those with empty grass-covered expanses. In addition, according to Fintikakis et al. (2011), increasing the number of urban trees in open public spaces plays an aesthetic role and offers a pleasant nature by alleviating the rigidity of the built environment, as well as contributing to relaxation of heat-stress, blocking noise, improvement of air quality and protection from wind.

Accepting that walking on streets is a behaviour that can be acquired and fostered, the physical environment "needs to be designed to support healthy behaviours. There is increasing recognition that shaping healthy behaviours, such as increased physical activity, will involve [...] reintroducing the natural world as a backdrop [...] encouraging individuals of all ages, friends, families, neighbourhoods and other identifiable social groups to be physically active" (Moore & Cosco, 2010: 37).

In a similar study, Sheets and Manzer (1991) carried out two studies measuring cognitive and affective reaction to vegetation in urban settings. In one study, participants viewed line drawings of streets with and without trees, while in the other they were shown slides of a suburban thoroughfare. In both cases, the addition of trees to the view increased the respondents "cognitions about the quality of life as well as the land-use of an area" (Sheets & Manzer, 1991: 295). Sheets and Manzer also found that the participants:

> "reported more positive feelings when viewing tree-lined city streets; they felt friendlier, more cooperative, less sad, and less depressed [...] vegetated scenes were rated as better, safer, and cleaner places in which to live, and as easier places in which to make a living" (Sheets & Manzer, 1991: 302).

Foltête and Piombini (2007) investigated the role of landscape in fostering pedestrian activity. These researchers demonstrated the use of landscapes was important "in order to understand how individuals determine their routine trips in an urban environment and how they are affected by these trips" (Foltête & Piombini, 2007:

226). The authors utilised a regression model with pedestrian counts as the dependent variable from a study frame of 1148 street sections, in Lille, France. They found that the frequency of pedestrians count was positively and significantly correlated with presence of trees, vegetation, squares and number of travel lanes. Pedestrian frequency was negatively and significantly correlated with residential tall buildings. They also found the spatial preference of pedestrians is influenced by "certain local characteristics such as presence of stores or other attractors, amenities that favour pedestrian movement, or even an attractive landscape" (Foltête & Piombini, 2007: 226).

Wolf (2003) found that the survey participants would visit business districts with trees more often, travel further, stay longer and pay more for parking. The same author (2004) found that street scenes with trees and buildings at urban densities were preferred by participants in a visual survey. His study found that both customers and merchants prefer street scenes with trees; however, customers' preferences were higher.

Maco and McPherson (2002) noted that "street trees are an important part of the tree canopy over the city because of their prominence along heavily used transportation corridors" (Maco & McPherson, 2002: 270). They reaffirmed six benefits of urban tree canopy: climate control; energy savings; air, soil and water quality improvement; storm water runoff mitigation; reduction of greenhouse gases; and increased real estate value. In this context, Rao et al. (2014), an interdisciplinary team of Portland State University researchers, carried out *in situ* measurements to examine the relationship between urban trees, air pollutants and respiratory health. The study found that mature trees significantly reduce the amount of noxious gases in the air. The study calculated the benefit of Portland's urban trees at nearly $7 million annually in prevented hospitalisations, emergency room visits and absences from school or work due to asthma and other respiratory illness.

Moreover, for the Saudi context, BaHammam (2004) concluded in his study of Riyadh city that no specific planting programme was observed along different streets. Al-Awais (1991) reached the same conclusion for Dammam city. Both studies point out that planting is mainly a practice by residents inside their dwellings.

Therefore, they assert the lack of street trees is a major contributor in creating useless, unpleasant and thermally uncomfortable pavements for pedestrians.

In connection with the latter observation, the findings of much empirical research show that urban plants play a major role in lessening the temperatures of the urban microclimate. Trees in the hot climate of Arab cities were found to improve the microclimate of urban streets, reduce ambient temperatures and provide a psychological cooling effect (Jaber, 2013). Nevertheless, because of the arid climate, not many large trees grow in Saudi Arabia today, except for palms and drought-resistant non-native (exotic) trees. Therefore, one of the critical functions of urban trees in the Kingdom is to modify the harsh climatic conditions.

Additionally, street trees can moderate the climate in four ways: by reducing the temperature, reducing solar radiation, controlling wind movements and preserving the moisture balance. Therefore, the effects of street trees on the meteorological conditions are significant in urban design, as the aim is to maintain human thermal comfort under all weather conditions (Mayer et al., 2009). Similarly, urban greening has positive effects on the thermal comfort of outdoor pedestrians, where greening with trees is still better than other methods (Lin et al., 2008). Thus, the experimental results of many studies demonstrate that a reduction in air temperature of ≥3°C can be effected by urban trees alone, which makes a lot of difference and is quite an achievement in transforming uncomfortable urban spaces into thermally acceptable places (e.g. Akbari et al., 1992; Robitu et al., 2006; Lin et al., 2010; Shashua-Bar et al., 2011; Lin et al. 2013).

Indeed, there are large differences between air temperatures in the sunny areas and in the shaded areas, which are mainly attributable to the capability of trees in reducing effects of solar radiation, and hence enhancing the microclimate of a certain area. The following are only some examples which have established that urban trees play a major role in lessening the temperatures of the urban microclimate in different regions.

Toudert (2005) found that air temperatures can be reduced up to 1.5K if rows of trees were available compared to unplanted streets, and differences can be larger if the row of trees is larger – mostly because of less warming of the ground under shade[14]. Another study carried out in Putrajaya, Malaysia, a city that is affected by tropical climate, showed that high tree density reduced urban air temperatures between 2.7°C and 3.5°C during the peak hours of the day in comparison to the same microclimatic conditions of an adjacent bare area (Shahidan, 2011). Similarly, Al-Awais (1991) reviewed a study undertaken during a hot summer day in Frankfurt streets and found the urban trees reduced the air temperature by 3.5°C in comparison to an adjacent bare area. He also reported a study discovered when the air temperature was measured on a grass lawn planted with trees, it was 5.6-7.8°C lower than above a bare soil surface.

In another study in Wollongong, a coastal city east of Australia, temperatures under native street trees were 2°C lower compared to those measured under exotic trees (Aguiar et al., 2014). For this reason, Szokolay (2014) stresses that the selection of plants is critical; thus experts should be consulted. He highly recommends, for hot climate regions, the use of trees that have a tall trunk, so as to allow free passage of the wind near ground level while shading the pavement for pedestrian comfort.

During daytime in hot climates, the fully planted urban space is the place in which the pedestrian thermal stress is the lowest. For example, Shashua-Bar et al. (2011) found the air temperature at peak daytime hours in a fully planted urban courtyard was lower than in a bare exposed courtyard by 2.5°C. Coutts et al. (2015) found trees in shallow street canyons very effective in reducing the mean radiant temperature during daytime hours in summer, leading to lowering the thermal stress of pedestrians from 38°C to 32°C. More clearly, in the hot climate of Saudi Arabia; “trees become dominant in determining the thermal characteristics of the microclimate conditions at street level” (Alznafer, 2014: 96).

Furthermore, depending on the street typology and targeted users, a row of large trees may be incorporated in central areas or planted on the pavements. Although the optimal location of trees within the street space depends on street orientation and

[14] According to Szokolay (2014: 5), K denotes Kelvin and represents the temperature interval or difference, on the scale of degree Celsius (°C), without specifying where the difference is on the scale. For example, 40°C − 10°C = 30K; nevertheless, 15°C as a point on the scale equals 288.15°K because 0°C = 273.15°K.

street aspect ratio, more than one row on the pavements is recommended (Al-Awais, 1991; Sheets & Manzer, 1991; Toudert & Mayer, 2006; Konarska et al., 2014). According to Toudert and Mayer (2006: 53), for deep street canyons, trees seem to be more relevant for E-W than for N-S orientation. This is attributed to the much longer period of discomfort, caused by long exposure to solar radiation, which occurs on the north side of the street space. But, for N-S oriented streets with H/W >1, the time of discomfort is limited to a short period around noon, thus may not necessitate planting.

Although they have been known for a long time for their detrimental effects (e.g. reducing air movement, damaging the pavement surface through roots), trees are a major player owing to their dual impact in controlling thermal stress (Mahmoud, 2011; Alznafer, 2014). As well as the evapotranspiration of water through the leaves surface having a general cooling effect on ambient air temperature, trees are also an effective source of shade (see point 5 under 3.3.8 for a detailed review).

One additional point made by Szokolay (2014: 81) is that “many architects tend to forget that trees grow, thus their effect will change over the years”. He suggests; “if any trees are to be planted, landscape advice should be sought on what they would look like in 10, 20 or even more years’ time”.

3.2.7 The Conflict over Street Design and Influences on Walking

Although urban streets are public open spaces to all, their physical and spatial design can clearly prioritise certain uses and users over others. Thus, street characteristics will either lead to car-dominant, pedestrianized or mixed-priority streets that provide choices (Calthorpe, 1993). It has been acknowledged that the current urban design, in most developing cities in Asia, including Saudi, has created unsound urban streets for pedestrians (Mateo-Babiano & Ieda, 2007; Jaber, 2013; Alznafer, 2014), but why?

In practice, once contemporary cities have become comprised of a complex layout of streets for both cars’ and pedestrians’ circulation, functional, aesthetical and physical conflicts have emerged (Tan, 2009), because “power over them is ambiguous, for the street has an open and easily changeable nature” (Appleyard in his foreword to

Moudon's *Public Streets for Public Use*, 1991: 9). Figure 3.2 shows this is due to the division of responsibility in street design between three professions (Marshall, 2005). Similarly, Gehl points out that "working with three scales means operating with three very different disciplines, each with its own playing rules and quality criteria" (Gehl, 2010: 195). In other words, buildings are designed by architects and roads by engineers, while the urban spaces in between are still areas of confused design responsibility. Ironically, it is these spaces that provide the setting for the life and activities of the city (Gibbons & Oberholzer, 1991; Gehl, 2011).

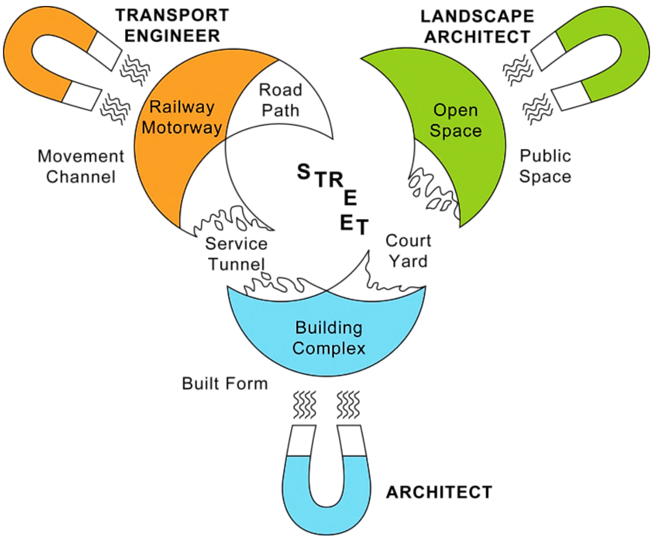


Figure 3.2 Urban streets have become lost and deconstructed space due to conflicts between the roles of various professions (Source: Marshall, 2005: 7)

Gehl (2010: 195) explains that urban design is a profession which involves work on three very different levels of scale. And in order to achieve a better quality of outdoor life it mainly requires coordinated work with these scales, as follows:

(a) *Large Scale*: is the holistic treatment of the city including quarters, functions and traffic facilities. This is the city as is seen from an aerial perspective;

(b) *Middle Scale*: is the development scale that describes how the individual spaces of the city should be designed and buildings are organized. "This is city planning from a low-flying helicopter perspective"; and

(c) *Small Scale*: is the pedestrian landscape where all people will be using it on a daily basis, where urban spaces will be experienced at eye level. Working with this scale is the key to better streets for pedestrians owing to the great attention given to the human dimension. What is interesting is the quality and details of this daily landscape as experienced by pedestrians walking at 5 km/h.

Pedestrians "move relatively slowly through the environment and are afforded an intimate experience of the environment around them that affects where and how long they choose to walk" (Moudon & Lee, 2003: 23). Therefore, it is important to assess characteristics of the immediate physical environment in detail, as one of the key influences on the decision to walk.

Walking conditions, according to Moudon and Lee (2003), depend on three factors: (a) interpersonal; (b) environmental; and (c) trip characteristic (i.e. purpose and length). Indeed, under each factor there are several components; however, they all interact in different ways to influence the decision to walk. Other variables play their role in this process, such as climate and socio-cultural attributes. In this context, Moudon and Lee also assert that walking and cycling are behaviourally-based activities, influenced largely by conditions of the urban environment. Consequently, three components are essential for careful consideration: (a) origin and destination; (b) street characteristics; and (c) characteristics of the areas surrounding the origin and destination.

3.2.8 Decline of Walking and Environmental Quality

Some researchers argue that the underlying cause behind the gradual withdrawal of pedestrians from urban streets is owing to a somewhat limited vision by municipalities, which may look at pedestrians as merely transients and urban streets as transitional spaces (e.g. Potvin, 2004; Jaber, 2013). Nevertheless, many sources confirm that urban streets are destinations per se, being the basic public places and the daily landscape where pedestrians are the main users (Gehl & Svarre, 2013; Hass-Klau, 2015).

According to Carmona et al. (2010), the declining rates in the use of urban spaces "is based on a false notion", and they further argue the relationship between users and space is "dynamic and reciprocal" (Carmona et al., 2010: 141). Gehl (2011), in addition, emphasises that the use of any public space by pedestrians is a strong reflection of the physical characteristics and environmental qualities encompassed within any given space. Therefore, the disappearance of pedestrians from the street space can be largely attributed to the lack of incentives and poor environmental quality. Supporting this postulate, Carmona recognises that "With a decline in their maintenance and quality, public spaces are likely to be used less, thereby exacerbating the spiral of decline" (Carmona et al., 2010: 141).

Moreover, other researchers attribute the decline in the use of urban spaces to the impact of shopping malls and the increasing attraction towards indoor public environments: "The recent retreat of public space before speculative forces has created an unprecedented interiorisation of the public realm and the loss of urban permeability and diversity […] the public domain has been controlled and stripped of its spatial and thermal diversity" (Potvin, 2004: 121).

Regardless of the powerful and competitive impact of indoor spaces, the reality is the transformation of urban streets into chaotic and dysfunctional space for walking. Streets have gradually suffered from being "lost space" (Trancik, 1986), and lack of any true visual and physical quality, leading to the sense of discontinuities, alienation, confusions and ambiguities (Lynch, 1965), and even more, the feeling of "placelessness" (Relph, 1976). Several sources attribute the development of this dilemma to the outdated practices of street design that keep prioritising cars over pedestrians (e.g. Campbell & Cowan, 2002; O'Hare, 2006; BaHammam, 2009; Koelbl, 2013; Newman & Kenworthy, 2015).

Such "entrenched practices" (Newman & Kenworthy, 2015) have contributed to produce a "blank three-dimensional surrounding that contains insufficient detail for a user on foot" (Tan, 2009: 141). This observation is based on the fact that pedestrians and motorists tend to have different experiences due to variation in speed of movement and distance from objects. Motorists are more likely to notice large scale and coarse-grained elements, while pedestrians need intimate space with smaller scale, finer-grained and detailed elements compatible with their low speed and close distance (Nasar, 1998; Hass-Klau et al., 1999; Gehl et al., 2006; Gehl, 2010; Carmona et al., 2010; Hass-Klau, 2015).

In this respect, it has been accepted that “The details that make a city distinctive and help define its materiality – the furniture that decorates the streets or the width of the pavement – provide a rich and rewarding city experience. These details are also best seen and evaluated by the pedestrian” (Wall & Waterman, 2010: 57). This, indeed, echoes the findings of Cullen (1961), Relph (1976) and Rapoport (1977) that pedestrians require noticeable differences, complexity and details at the eye level (Gehl, 2010). In this context, Gehl (2010: 82), documenting a personal conversation with Ralph Erskine, stresses that:

> “If the complex is interesting and exciting at eye level, the whole area will be interesting. Therefore, try to make the edge zone [of street] inviting and rich in good detail, and save your efforts on the upper floors, which have far less importance both functionally and visually”.

Consequently, to reclaim urban streets for walking and restore pedestrians, designers should concentrate on the microscale of street space, namely, the physical and spatial details on pavements, which hence necessitates some criteria to be identified. In an attempt to illuminate such factors, Table 3-3 reviews some of the common vocabulary of street design discussed in the pertinent literature.

Table 3-3 Vocabulary and quality criteria of street design for pedestrians (Source: the author)

Quality Criteria	Author	Carmen Hass-Klau	Jan Gehl	Project for Public Spaces	Dft and Communities and Local Government	Transport 2000 Trust	The House of Commons	The Institute of Civil Engineers	Project for Public Spaces	English Partnerships	Carmen Hass-Klau	Allan Jacobs	Donald Appleyard
	Title	The Pedestrian and the City	Cities for People	Streets as Places	Manual for Streets	Your Route to a Better High Street	Living Places	Designing Streets for People	How to Turn a Place Around	Urban Design Compendium	Streets as Living Space	Great Streets	Liveable Streets
	Year	2015	2010	2008	2007	2004	2003	2002	2000	2000	1999	1993	1981
Protection	1	Safe	Safe	Safe	Safe	Removing railings and unnecessary posts	Safe	Safe	Safe			Safe	Safe
	2	Reclaim streets from traffic/ Traffic calming	Secure	Vitality of streets	Cultural responsive			Meet people	Sociability	Sociability	Sociable	Community involvement	Community
	3	Increase community cohesion/ Community engagement	Protection against unpleasant sensory experiences	- Liveable - Vendors	Strengthen communities	Reduce traffic speed	Clean	- Happy to Live - Clean			Liveable		Liveable
	4	Enforcement	Eliminating fear of traffic; Balance traffic/ life	- Traffic calming - Road humps		Improving public transport/					Modest traffic		Sociable
Connectivity	5	Accessibility	Accessibility for everyone	Accessibility	Access	Providing cycle lanes			Accessibility	Connection		Accessibility	Connectivity
	6	Independent pedestrian footpaths	Movement space	Cohesion	Connected movement	Improving public transport / sustainable		For movement	Linkage	Pedestrian-oriented			
	7	Prioritising pedestrians over cars	Opportunities to walk	Small streets more for walking	Balance	Reduce car journeys							
Comfort	8	Wide pavements	Room for walking	Ample sidewalk		Wider pavement	Pedestrian friendly		Comfort	Comfortable	Comfortable	Physically comfortable	
	9	De-cluttering the street space	No obstacles	Comfort		Walking environment			Improve Walking	Convenience			
	10	Flat surfaces	Good surfaces										
	11	Climate responsive streets	Opportunities to stay	Comfortable to stop							Thermal comfort		
	12	Encourage staying	Opportunities to sit; rest	- Places to Sit - Nice to sit down			Well-lit streets						
	13	Lighting	Opportunities to see; Attractiveness	Attractiveness			Attractiveness	Attractive	Attractive	Conspicuousness		Attractive	Well-lit streets
	14		Opportunities to talk/ listen	Meet and talk									
	15		Opportunities for play/ exercise	Pleasant to go									
Delight/ Enjoyment / Wellbeing	16	Micro-scale solutions	- Human scale - At street level	A down-to-earth scale		Education							
	17	Streetscape principles	Opportunities to enjoy or avoid climate aspects	Narrowing streets & lanes		Improving air quality							
	18	Improving the street scene	Interesting facades; Visual quality	Personality	Identity				Image		Character	To be remembered	Unique history
	19	Detailing	Good design/ detailing	Signs	Sense of place						Historical identity	Artfully	
	20	Maintenance	Good materials	Maintenance & management	Quality				Quality pavement			Superior character and quality	
	21	Pocket gardens	Interesting street furniture	Sidewalk cafés	Maintenance								
	22	Water features	Fine views; Enjoyment	Public art	Attractive		Enjoyable	Enjoyable	Enjoyable	Convivial	Beautiful		Pleasant
	23	Green streets	Trees, plants & flowers	Trees & flowers		Greening streets	Green				Nature	Trees	Green
	24	Attractive street furniture	Day and night, summer and winter activities	Activities at street level	Diversity				Enhancing economic activities		Diversity	Diversity	
	25	Mixed-use activities for pedestrians	Mixed-use activities for pedestrians	Mix of activities				For shopping	Mixed-uses & activities		Mixed-use		
	26		Healthy; Public life		Place	Revitalizing community		For people				Encourage participation	Healthy

3.3 PART TWO: Pedestrians' Thermal Comfort

3.3.1 Overview

This section of the chapter presents the theoretical backgrounds underpinning this study of the urban microclimate and design, as well as the aspects pertinent to the thermal comfort of pedestrians. It initially reviews the subject at the larger scale in terms of the relation between walking, outdoor spaces and microclimate. It then presents classifications of the urban microclimate and the related literature dedicated to the investigation of climatic phenomena commonly observed in urban areas.

Following that, more attention is given to the literature focused on the theory of outdoor thermal comfort and urban microclimate design in hot climates, particularly the effects of design interventions applicable for the existing street conditions with respect to the microclimate at pedestrian level, and thus thermal comfort. This includes reviews of some of the thermal comfort indices applicable for outdoors, coupled with the *in situ* measurement equipment best fitted for the context of this study.

Moreover, when discussing urban microclimate and outdoor thermal comfort, it is always useful to clarify the intended meaning behind frequently used terminologies. This is particularly important when certain terminologies are used interchangeably for the same purpose, while technically each term has different usage. Accordingly, the following paragraphs define some of the most repeated terms in this part of the chapter.

3.3.2 Climatological Definitions

Among the first relationships, a distinction between weather and climate should be made. ***Climate*** encompasses the concept of weather so that it is defined as the accumulation of averages of daily and seasonal weather events over a long period of time at any particular location, whereas ***weather*** refers to the set of atmospheric conditions prevailing at a given place and time (Szokolay, 2014). According to the National Oceanic and Atmospheric Administration (NOAA), weather reflects short-term circumstances, which can change from minute-to-minute, day-to-day and season-to-season– or simply, climate is what you expect and weather is what you get.

While ***local climate*** is the average climate for a city or region, microclimate is a more specific term pertinent for this study. The ***microclimate*** is the distinctive local climatic conditions of a small-scale or limited space (e.g. neighbourhood parks, urban plazas and streets), which is relatively rapidly changing or momentary. “The microclimate […] can show substantial variations, but such variation can also be produced deliberately” (Szokolay, 2014: 80) and can vary from other adjoining areas according to the surrounding properties (natural or man-made). Thus, it can heavily impact whether outdoor users stay or leave (Gehl & Svarre, 2013).

Ambient Air Temperature **(Ta):** is the average temperature of the air surrounding users with respect to location and time (ASHRAE, 2004), and is considered “the dominant environmental factor, as it determines convective heat dissipation” (Szokolay, 2014: 16). As a standard, air temperature measurements are taken at levels of the ankle, waist and head. These levels are represented numerically at heights of 0.1, 0.6 and 1.1m, respectively for seated users; and 0.1, 1.1 and 1.7m for standing users (ASHRAE, 2013).

In hot-arid climates, nocturnal air temperatures are typically significantly lower than diurnal temperatures throughout the year. Diurnal temperature differences in summer months “between the average daily maximum and minimum range between 15 and 19°C […] Therefore, the critical months of the year are the hot months, and mitigating the temperature extremes of this season is a must” (Ratti et al., 2003: 56-57).

Mean Radiant Temperature **(Tmrt):** is the spatial average temperature of the surrounding surfaces to users (ASHRAE, 2004; Szokolay, 2014), and “can be defined in two ways. With respect to the radiant field, it is the temperature of a uniform enclosure with which a ‘small black sphere’ at the test point would have the same radiation exchange as it does with the real environment. The alternative definition is concerned specifically with the human body; it is the same definition as the aforementioned one with the words ‘human body’ replacing ‘small black sphere’” (Parsons, 2014: 104). The Tmrt cannot be measured directly, but can be estimated by globe temperature (Tg) measurements (**Equation 2**); in the absence of air movement, the Tmrt = Tg (Szokolay, 2014).

The effect of the Tmrt on outdoor users with light clothing in hot climates can be twice as significant as the Ta, “which gives rise to the environmental temperature” (Szokolay, 2014: 17). Thus, the Tmrt “can be more than 30 K higher than Ta in exposed locations and even up to 5 K in shaded parts, due to the diffuse and reflected solar radiation components” (Toudert, 2005: 20). As such, high values of shading density at the microscale of the street space “are beneficial in hot-arid regions as they provide protection to pedestrians and to the horizontal street surface from solar radiation” (Ratti et al., 2003: 57).

Relative Humidity **(RH):** humidity in general is a term referring to the water vapour contained in the air, although several sources identify other types of humidity that can be quantified (e.g. Szokolay, 2014; Parsons, 2014; Met Office, 2014). Nevertheless, the RH is the most common measure of humidity and more relevant in this study. It can be defined as the measure of how much water vapour there is relative to the air temperature - that is the percentage of the total amount of moisture contained in the air compared to how much there could be at that temperature (Watson, 2013; Szokolay, 2014).

The RH is often taken into consideration in outdoor thermal comfort studies, as it affects the body’s cooling mechanism, ‘sweating’, and thus how outdoor users actually feel the ambience. The thermal state of the human body is largely dependent on the condition of the air, because it absorbs and removes moisture from the skin to cool it down. When the air is heavily laden with moisture, it cannot contain any more water vapour, and hence cannot effectively evaporate the sweat from skin. Accordingly, high and low levels of RH within urban spaces can have adverse effects on the comfort state of outdoor users.

For example, combined with high air temperatures, air laden with humidity causes discomfort, as the high humidity restricts “evaporation from the skin and in respiration, thus curbing the dissipation mechanism” making the body feel warmer and even stifled (Szokolay, 2014: 17). Thus, failure to maintain an optimal level (30-65%) (ibid.) or effectively cope with high rates of RH in hot-humid areas, mainly by means of increasing air velocity, often leads to uncomfortable thermal experience (Cândido et al., 2010; Ng & Cheng, 2012).

***Wind Velocity* (v):** is the average speed of the air to which the body is exposed, with respect to location and time (ASHRAE, 2004). Wind velocity produces a physiological cooling effect because it (a) accelerates convection; (b) changes the skin and clothing surface heat transfer coefficient; and (c) increases evaporation from the skin (Szokolay, 2014).

The air movement within the street space is a dependent quality on the primary wind flow and direction outside and above the space. However, air movement at this scale can be highly affected by the urban geometry, including street orientation to wind flow, aspect ratio of buildings' height to street width (H/W), angle of rooftops to direction of wind flow (Oke, 1988; Erell et al., 2011a; Alznafer, 2014), as well as roughness and characteristics of external surfaces (Oke, 2006; Szokolay, 2014).

Increasing air velocity in a hot-humid climate is the most effective cooling strategy to maintain thermal comfort (Ng & Cheng, 2012). For example, the main results of a study conducted in such a climatic context, in Brazil, found that attaining thermal comfort is significantly correlated with rate of air speed. The minimal acceptable air velocity was at least 0.4m/s at 26°C. The satisfactory limit increases as the temperature increases, reaching 0.9m/s at 30°C (Cândido et al., 2010).

Although the last findings were identified for indoor users during a light activity, availability of air movement becomes much greater in outdoors. As is the case in this study, in outdoor spaces of coastal cities with hot and humid climate in; for example, Brazil and Taiwan, the effect of wind velocity is a critical factor for mitigating thermal discomfort conditions for pedestrians. Therefore, pedestrians prefer higher air velocity (Lin, 2009; da Silva & de Alvarez, 2015). For example, in Singapore, "a wind speed of 1–1.5m/s creates a cooling effect that is equivalent to a 2K drop in temperature, thus improving the thermal comfort of the street users". This air velocity is also recognised low enough not to cause any discomfort to the pedestrians (Erell et al., 2011a: 247). In such a climatic context, it becomes increasingly accepted "to cool urban spaces using wind towers or fans to circulate the air" (Yang & Clements-Croome, 2013: 394), for example Figure 3.24 and Figure 3.27.

3.3.3 Urban Microclimate

Of prime importance for a climatically responsive urban design study is to understand drivers of the urban microclimate which, in turn, have strong implications for the sustainable built environment. In general, microclimatology focuses spatially on the lowest portion of the *troposphere*[15], in which humans live and breathe, known as the *Atmospheric Boundary Layer* (ABL). This layer extends from the earth's surface upwards and is usually around 1km thick. However, depending on the underlying roughness and wind velocity (Figure 3.3), it can range from 200m above an open area to more than 500m over urban centres (Alznafer, 2014; Szokolay, 2014). The ABL is characterised by varying diurnal temperatures, as well as the exchange of momentum, heat fluxes and water vapour at the ground surfaces.

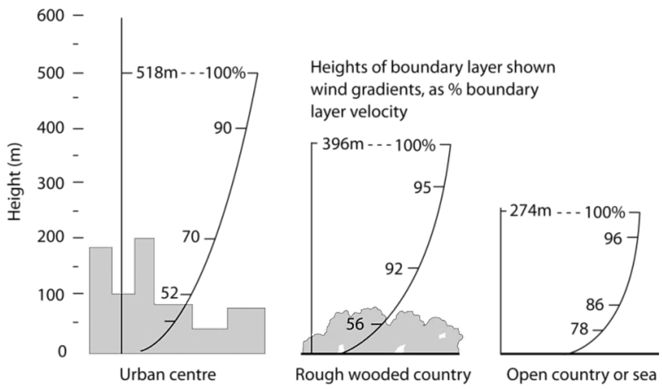


Figure 3.3 Depth of the Atmospheric Boundary Layer in accordance with wind velocity and roughness of surfaces (Source: Szokolay, 2014: 79)

Hence, every small-scale turbulent transfer and exchange process which may occur within the first 100m above the ground surface is important in determining the state of the whole layer (Garratt, 1994; Kaimal & Finnigan, 1994). In contrast, the region of atmosphere above the ABL reacts slowly to any changes that may occur near the ground, and the condition within such an atmospheric region mainly depends upon the changes at the larger scale. Moreover, above urban areas, the atmosphere can be further divided into sub-layers, owing to additional variables involved in determining

[15] The *troposphere* is the lowest/closest region of the four atmospheric layers above the earth's surface extending from the ground to a height about 10km, followed by the *stratosphere* (10-50km altitude), the *mesosphere* (50-80km) and the *thermosphere*.

the climatic condition near the urban surface. Figure 3.4 illustrates two atmospheric layers within and above urban areas; namely, the ***Urban Boundary Layer*** (UBL) and the ***Urban Canopy Layer*** (UCL).

- The UBL develops as the wind passes over an urban area and extends upward from the average height of buildings' rooftops to about ten times the average building's height. In this layer, the climatic condition becomes homogeneous and decisively determined by the roughness of the urban structure, surface characteristics and anthropogenic activities within the urban setting. The atmospheric condition can extend horizontally over the rural areas, according to the regional wind direction.
- The UCL grows below the UBL and extends from the ground surface up to about the average height of buildings' rooftops. The climate conditions are relatively heterogeneous, and mainly determined by the nature of its surroundings – particularly the physical and spatial characteristics of the urban environment and thermal properties of the urban surfaces (Oke, 1988). Thus, a complex urban form could increase the turbulence processes and lead to a mosaic of microclimatic conditions (Oke, 2002).

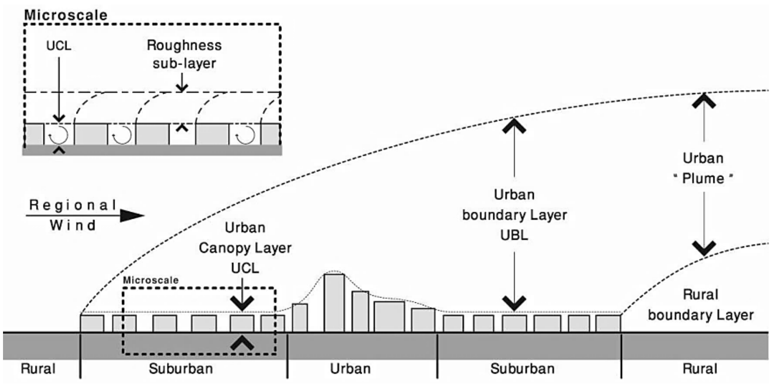


Figure 3.4 The atmospheric sub-layers, including the homogeneous boundary layer above the urban setting and the heterogeneous canopy layers between buildings (Source: Erell et al., 2011a: 16)

The microclimate conditions within the UCL have received the largest amount of attention, because of the great impact on the use/non-use of urban spaces, as well as being the most closely related to pedestrians (e.g. Toudert, 2005; Erell et al., 2011a; Alznafer, 2014).

3.3.4 Walking, Urban Streets and Outdoor Microclimate

People, for centuries, have always adopted diverse adaptation strategies – whether architectural or human-based – compatible with the characteristics of their climatic zone, in order to provide a thermally acceptable environment for living, mainly indoor: to name some examples, building a fireplace, moving to cooler or warmer rooms, raising or lowering roofs, narrowing or widening windows, adopting a courtyard house design, building a wind-catcher '*Badgir*'. Therefore, a considerable amount of literature on indoor thermal comfort has been available since, at least the early 19th century (Abdel-Ghany et al., 2013).

This can be partly attributed to the fact that most studies were carried out in developed countries, temperate or cold, where the majority of people usually spend more than 90% of their time indoors (Leech et al., 2000; Spagnolo & de Dear, 2003). Another recognised reason is due to the fact that the indoor climate is relatively constant compared to the variability of the parameters out of doors (Auliciems & Szokolay, 2007; Nicol et al., 2012). However, when it comes to the outdoor environment; particularly the street, there is a totally different scenario.

The urban street is a dynamic open space influenced by climatic variables that are uncontrollable without protection measures, due to seasonal changes and even on daily basis. Thus, it becomes hard to adopt certain methods of control that fit all seasons everywhere, owing to the volume of streets in cities and the variety of climates that need to be addressed, compared to a set of individual or clustered buildings (Toudert, 2005).

Nevertheless, some societies in different parts of the world have adopted, mainly in the past, certain **'passive'** planning patterns to survive with the prevailing climate. For instance, the compact form of the traditional Arab city with narrow winding street layout has been widely implemented from the west coast of Morocco to the east coast of the Gulf countries, so as to acclimatize with the severity of the hot conditions (Alznafer, 2014). Since the 1950s, once the modern planning paradigms, influenced by advancements in transport, had accelerated in the most developed countries, these models have been mimicked in other places in the less developed countries. One of the negative implications of this copy-paste activity is the neglect of local climatic conditions, leaving adaptation to be achieved through the mechanical or **'active'** heating/cooling systems (Jaber, 2013).

It has been already recognised that "modern cities have rarely been shaped by a concern for a comfortable outdoor climate" for pedestrians (Bosselmann et al., 1995: 227). In fact, almost all modern cities have transformed into an "internationalist" model, with little attention given to the local context, including climatic conditions, topography and socio-cultural attributes (Turner, 1996: 104). In this context, Turner (1996) sheds light on some notes documented by an explorer who visited Jeddah, a city located on the western coast of Saudi Arabia, and Iceland during the 19th century. The explorer reported distinctive differences between both settlements, in terms of planning patterns and urban morphology, which were based on each context's local climate and culture.

In contrast, significant differences in the same places were hardly identifiable by the late 20th century (Turner, 1996). Such an observation emphasises how the important determinants that were essential to the sustainability of human settlements have no longer been taken into account today. This transformation could be partly attributed to the concept of globalisation that has affected almost every aspect of life, and partly due to the perception of the less developed societies towards the most developed countries. This latter interpretation may be the most influential factor in, for example, the Saudi context, where the society has admired the Western culture and lifestyle (Fadan, 1983; Al-Said, 1992; Abu-Ghazzeh, 1997; Al-Naim, 2008b).

Moreover, when considering impacts of urban microclimates on outdoor life, Gehl argues that "If people are walking from point A to point B, they can usually live with suboptimal wind, sun or shadow conditions, but for staying activities a place needs a higher level of climate quality" (Gehl & Svarre, 2013: 15). For this, Whyte (2009) considers the lack of wind, availability of sunlight and warmth are important elements of attractive streets, although he points out that sunlight becomes less essential during summer. Hass-Klau (2015) confirms that the features identified by

Whyte and Gehl become crucial within the temperate zone of the northern hemisphere, specifically, Europe and the northern US. Hass-Klau also highlights that these criteria are “more of an issue when sitting down and not that important when walking” (Hass-Klau, 2015: 278).

However, rather than focusing on sedentary activities in public open spaces, de Montigny and others (2012) established that walking rates on streets, in nine selected cities in the same temperate zone of the same hemisphere, were considerably influenced by weather variables. They considered walking as a better indicator than merely attendance in urban spaces “because walking encompasses all movements, whereas public space attendance is a relatively small subset of walks, usually with recreational or leisure content” (de Montigny et al., 2012: 822).

Consequently, “Investigating the comfort conditions of open urban spaces, a differentiation has to be drawn between routes and resting places” (Nikolopoulou, 2004: 103). This is attributed to the fact that urban microclimates affect outdoor thermal comfort during walking and sedentary activities differently; thus “there is a tendency for lower physical activity as air temperature increases” (Nikolopoulou, 2011: 1559-1560). More clearly, “walking is more comfortable than sitting when the air feels cold, but sitting in the shade is more comfortable than walking in direct sunlight under hot conditions” (de Montigny et al., 2012: 822).

In this regard, Gehl; in several publications, confirms that even without optimal climatic conditions, in cold areas such as Denmark, streets can still be full of active pedestrians. Although this observation maybe true for temperate zones, it is possible that it is reversed for hot areas, given that the situation is quite the opposite, where physical activities might cause heat stress (Parsons, 2014), which thus imposes more challenges on street design.

Under hot climate, “Pedestrian thermal comfort [is a] higher priority than direct daylight availability” (Ratti et al., 2003: 58); thus quality of the “thermal environment affects pedestrians’ tendency to stay or leave the place” (Ghasemi et al., 2015: 399). Hence, to encourage people to walk in the first place, and for those who already walk to enjoy the experience and stay longer, a higher level of awareness towards climatically responsive urban design is necessary (Hebbert & Jankovic, 2011).

At present, urban streets are designed without proper consideration toward better thermal environmental quality for pedestrians' comfort and their "movement patterns can lead to potentially conflicting movements and can discourage walking" (Vasilikou & Nikolopoulou, 2014: 102). Additionally, "At the urban design scale it is useful in all streets to attempt keeping one side footpath shaded in the summer and one side sunny in the winter to allow people a choice which side to walk on" (Szokolay, 2014: 80). On the basis of the above preliminary review, the following paragraphs discuss some of the literature focused on the theory of outdoor thermal comfort, with special concentration on hot climates and walking on streets.

3.3.5 Theory of Outdoor Thermal Comfort

Studying outdoor thermal comfort; "although a growing field of research, remains under-researched" (Vasilikou & Nikolopoulou, 2014: 102). However, it has received attention since the second half of the 20th century and is still on-going (Abdel-Ghany et al., 2013). Although most of these studies have been conducted in temperate climates (O'Hare, 2006; Aljawabra & Nikolopoulou, 2010), recently, the subject has increasingly become of research interest in other climates. This is attributed to the fact that outdoor thermal environment directly affects: (a) the quality of outdoor life; (b) outdoor users' behaviour; and (c) the use of outdoor spaces (Nikolopoulou & Lykoudis, 2006, 2007; Sharmin et al., 2012; Ghasemi et al., 2015). Another rationale is the implications that go beyond the requisites of creating climate-responsive streets (for restoring pedestrians) into reduction of energy consumption in buildings (e.g. Ahmed, 2003; Alznafer, 2014).

Additionally, it is always a fruitful activity to understand the roots and associated basics of the phenomenon under study; hence understanding the physiological basis of the human body towards thermal equilibrium, the so-called "body's heat balance", is fundamental. Fanger (1970), in his book *Thermal Comfort*, places this subject within the notion of the body's heat balance; so that heat flows to and from the human body are balanced. Thus, Fanger describes the state of comfort as satisfied when: (a) core temperature; (b) skin temperature; and (c) sweat rate, are all within the limit of subjective comfort. For Hensel (1981), these parameters can be expressed; in a more measurable way, as (a) core temperature 36.5-37.5°C; (b) skin temperature of 30°C at the extremities and 34-35°C at the body stem and head; and (c) the body is free of sweating.

For ASHRAE[16] (2009: 9.1), the core temperature, during rest in comfort, maintains its level at 36.8°C and increases to 37.4°C when walking and 37.9°C when jogging. Simultaneously, the skin temperature in sedentary activities needs to be maintained at 33-34°C or 31-34°C (Auliciems & Szokolay, 2007) and decreases with increasing physical activity. Such information reveals that while the internal temperature rises with increasing level of physical activity, the skin temperature decreases, owing to the mechanism of sweating, which facilitates heat loss. Heat dissipation is a physiological adaptation towards uncomfortable rates of thermal conditions, to bring the body into a state of thermal equilibrium (Szokolay, 2014).

However, the above information places thermal comfort exclusively within a thermo-physiological approach, which has been questioned by several studies regarding its applicability for outdoor users (e.g. Nikolopoulou et al., 2001; Toudert, 2005; Setaih et al., 2013; Alznafer, 2014). Outdoor users experience much higher variations than those indoors, owing to the solar and terrestrial radiation fluxes (Matzarakis et al., 2010; Ghasemi et al., 2015). Taking these fluxes into account in outdoor spaces is "decisive because [they are] extremely variable spatially as well as temporarily" (Toudert, 2005: 42).

Figure 3.5 shows the various parameters influencing heat exchange of the body with its surrounding environment in outdoor settings. Some of these are induced by meteorological parameters, whereas others are related to bodily characteristics, and can be expressed by Equation 1 (Matzarakis & Amelung, 2008: 165):

$$M + W + R + C + E_{D} + E_{Re} + E_{Sw} = S \qquad \textbf{Equation 1}$$

where M is the metabolic rate (i.e. internal energy produced by oxidation of food), W is the physical work output, R is the net radiation of the body, C is the convective

[16] The American Society of Heating, Refrigerating and Air Conditioning Engineers.

heat flow, E_D is the latent heat flow to evaporate water into water vapour which diffuses through the skin (imperceptible perspiration), E_{Re} is the sum of heat flows for heating and humidifying the air, E_{Sw} is the heat flow due to evaporation of sweat, and S the storage heat flow for heating or cooling the body mass.

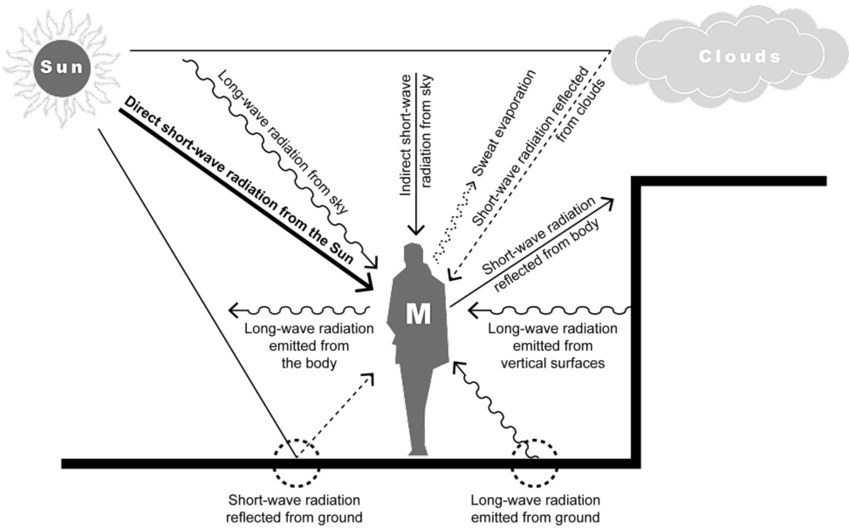


Figure 3.5 Factors affecting thermal balance of outdoor users (Source: Alznafer, 2014: 48)

Moreover, outdoor users are subjected to the influence of other parameters; although at varying degrees (Höppe & Seidl, 1991). For this, the ASHRAE (2010: 3) defines thermal comfort as ***"the condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation"***. Some researchers argue this definition is vague, because other factors play an influential role when studying outdoor thermal comfort (e.g. Nikolopoulou, 2011; Alznafer, 2014; Algeciras et al., 2015). Hence, the ASHRAE (2009) identifies six key factors that affect the state of thermal comfort and classifies them into two categories:

A. Environmental factors:

(1) Ambient air temperature (*Ta*) °C

(2) Relative humidity (*RH*) %

(3) Air movement/ Wind velocity (*v*) M/S, and

(4) Mean radiant temperature (*Tmrt*) °C

B. Thermo-physiological factors:

(5) Clothing resistance (*Clo*), and

(6) Activity 'metabolic rate' (*Met*)

Nevertheless, outdoor thermal comfort is not solely dependent on these two factors because they “cannot fully explain subjective perceptions or preferences of people due to the impacts of their personal, psychological and behavioural adjustments” (Lin et al., 2013: 83). For example, personal attributes may include: age, gender, body shape, state of health, diet and ethnic grouping. Even more, thermal comfort may become more complex when certain socio-cultural attributes are involved (Knez & Thorsson, 2006; Knez et al., 2009; Aljawabra & Nikolopoulou, 2010; Nikolopoulou, 2011), hence “may influence the *effective thermal preference* of people” (Auliciems & Szokolay, 2007: 15).

Accordingly, Szokolay (2014) further classifies the factors affecting heat dissipation from the body and thus, also, thermal comfort, into three groups (Table 3-4). A good relevant example is seen in the findings of Alznafer (2014), under summer conditions in the Saudi capital, Riyadh, located in a hot-arid climate. He found the pedestrians more tolerant to high heat conditions were those aged ≥ 30, and those who were fasting or had not consumed food/drinks within the last 15 minutes prior to the interview voted that they were thermally comfortable or preferred no change.

Table 3-4 Factors of thermal comfort (Source: Szokolay, 2014: 16)

Environmental	Personal	Contributing factors
Air temperature	Metabolic rate (activity)	Food and drink
Air movement	Clothing	Body shape
Humidity	State of health	Subcutaneous fat
Radiation	Acclimatization	Age and gender

Without diminishing the important role of personal, environmental and physiological factors, “thermal comfort is, at least in part, a psychological phenomenon open to influence by variables other than thermal” (Steane & Steemers, 2004: 6). Indeed, the psychological factor “plays a critical role to ensure thermal comfort and satisfaction with the outdoor environment” (Nikolopoulou, 2011: 1552). It can include; for example, the thermal history of the users (i.e. past experience, habituation, expectation) (Nikolopoulou & Steemers, 2003); preferences (Aljawabra & Nikolopoulou, 2010); characteristics of the physical surrounding (e.g. colour of space, level of noise, street furniture, materials) (Fanger et al., 1977; Höppe & Seidl, 1991; Rohles Jr., 2007); as well as type of activities (Nikolopoulou et al., 2001). Accordingly, outdoor thermal comfort is:

> "not just an outcome of the physical environment [...] Comfort is a complex perception [...] built out of the intersection between objective stimuli with cognitive and emotional processes. [...] Comfort is a complex and dynamic combination of the user's state of mind and experience of space" (Brager & de Dear, 2003: 179).

In relation to the experience of space, it is important to highlight the significance of adaptation mechanisms of pedestrians in expressing their satisfaction with a thermal environment, because people in different climatic regions "develop certain expectations about their own daily experience of the climate, in consequence engaging in certain adaptive responses" (de Montigny et al., 2012: 822). According to Nikolopoulou, in several publications, these mechanisms include (a) physiological; (b) physical; and (c) psychological adaptation.

Although the first response is referred to as "genetic adaptation or acclimatization" (Ghasemi et al., 2015: 400), which becomes a crucial mechanism under extreme conditions (Nikolopoulou, 2004; Alznafer, 2014), it is "not of central importance in the use of outdoor spaces" (Nikolopoulou, 2004: 109). Thus, the last two forms of adaptation become "very important in outdoor thermal comfort" (Nikolopoulou, 2011: 1559). The following sections describe each one briefly.

The physiological adaptation involves all changes that occur in the physiological processes, including the thermoregulatory system, resulting from the repeated exposure to certain climate conditions. Hence, it drives frequent outdoor users into a gradual acclimatization which, over time, reduces the possibility of the body experiencing stress. However, "it is the peripheral skin temperature that would vary; which in most cases would be followed by other forms of adaptation" (Nikolopoulou, 2011: 1559).

The physical adaptation refers to the changes that people adopt, whether at the personal or environmental level. It is divided into two forms: **(a) reactive,** which depends on microclimatic conditions, leading outdoor users to adjust themselves by, for example, changing levels of clothing and/or physical activity, increasing consumption of cool drinks with increasing temperature or moving into sunny or shaded areas; and **(b) interactive,** by means of modifying the physical environment to improve comfort needs, such as equipping outdoor spaces with parasols, awnings or even with water sprinklers or heaters and planting trees.

Apart from the strong effects of physiological and physical adaptations on the thermal perception of outdoor users; ***the psychological adaptation*** has been increasingly seen, by researchers, as important in determining thermal satisfaction in urban spaces (Steane & Steemers, 2004; Nikolopoulou, 2011). This approach means that outdoor users perceive the surrounding environment according to the information and experience they bring into that particular space. In turn, this makes them more tolerant (Alznafer, 2014) influencing their thermal perception of the environment and the changes occurring in it (Nikolopoulou, 2004).

According to Nikolopoulou and Steemers (2003), parameters of the psychological adaptation which have been identified to have a considerable influence on the thermal sensation of outdoor users are: (a) naturalness; (b) expectations; (c) experience; (d) time of exposure; (e) perceived control; and (f) environmental stimulation. However, “the relative influential weight of each parameter has not been identified yet” (Alznafer, 2014: 49).

Apart from the complexity of the interrelations discussed above, the theory of outdoor thermal comfort is that it is a subjective sensation that differs from one person to another; thus, several factors share an influential part. It is strongly influenced by the nature of the surrounding urban space and its characteristics, meteorological parameters and human-based considerations. Nevertheless, when the thermal parameters in any place become within an acceptable range, at least 80% of users performing sedentary or light physical activities can feel that place is thermally acceptable (ASHRAE, 2004).

Hence, design interventions – as facilitating conditions, according to the TIB – can play a critical role in ensuring outdoor thermal comfort in urban spaces by, for example, increasing “the range of psychological adaptation that could take place” (Nikolopoulou & Steemers, 2003: 100), modifying microclimates in regions with extreme climatic conditions and hence mitigating circumstances of heat stress (Toudert, 2005; Setaih et al., 2013; Alznafer, 2014).

When intensity of thermal conditions is below the limits of heat stress; “personal idiosyncrasy, culture, and socially conditioned value judgements all influence subjective response and preference” (Brager & de Dear, 2003: 179). However, in regions with extreme climate conditions, studies of thermal comfort “by necessity tend to focus on physiological limits” (ibid.). Accordingly, the urban microclimatic conditions associated with outdoor thermal comfort are “those where occupants feel neither warm nor cold, where ambient conditions are ‘neutral’” (Nikolopoulou & Steemers, 2003: 98). Therefore, unlike the hot-arid climate, it has been already acknowledged that under hot and humid conditions all the four environmental factors affect outdoor comfort (e.g. Lin et al., 2008; Ng & Cheng, 2012; Lin et al., 2013; Lin et al., 2014).

Nevertheless, a very recent study reaffirms the findings of previous research by identifying that wind velocity is a major player affecting pedestrians’ thermal comfort on streets in such a climatic context, owing to the cooling effect of air movement to mitigate impact of humidity. Da Silva and de Alvarez (2015), in an assessment of pedestrians’ perception of and preferred wind velocity during three seasons in a hot-humid coastal city in Brazil, found:

(a) The majority of participants perceived wind as being weak and they would prefer its velocity to increase. Specifically, during winter, the acceptable range of wind velocity was 0.9-2.4m/s; the upper limit increased to 2.9m/s in spring and in summer, a much higher velocity was preferred, up to 3.4m/s (Table 3-5);

(b) As the Ta increased with high RH, pedestrians’ preferred v increased;

(c) Satisfactory air movement in urban streets is crucial for mitigating conditions of thermal discomfort, and climatic-responsive urban design interventions are an important strategy to regulate this factor; and

(d) Configuration of the urban environment affects wind velocity, i.e., “higher building heights result in lower wind speeds at pedestrian level”. For this, the greatest reduction in wind velocity takes place in streets located behind buildings facing the wind direction, with short distances in between (da Silva & de Alvarez, 2015: 63).

Table 3-5 Scale of wind perception and preference, and corresponding temperatures in hot-humid coastal city, Brazil (Source: da Silva & de Alvarez, 2015: 68)

Wind velocity range (m/s)	Perception	Preference
Winter (22.9-28°C)		
≤ 0.9m/s	Weak wind	Stronger
0.9m/s < wind ≤ 1.9m/s	Stable	No change
1.9m/s < wind ≤ 2.4m/s	Well ventilated	No change
> 2.4m/s	Strong wind	Weaker
Spring (29-33.1°C)		
≤ 0.9m/s	Weak wind	Stronger
0.9m/s < wind ≤ 1.9m/s	Stable	No change
1.9m/s < wind ≤ 2.9m/s	Well ventilated	No change
> 2.9m/s	Strong wind	Weaker
Summer (35.2-37.2°C)		
≤ 1.4m/s	Weak wind	Stronger
1.4m/s < wind ≤ 2.4m/s	Stable	No change
2.4m/s < wind ≤ 3.4m/s	Well ventilated	No change
wind > 3.4m/s	Strong wind	Weaker

Furthermore, addressing the issue of thermal comfort typically encompasses complex mathematical calculations, as well as requiring appropriate data collection methods, devices and analytical tools. Therefore, the next sections review such components, to find those that best fit into the context of this study.

3.3.6 Thermal Comfort Indices

One of the central questions in any thermal comfort study is how to assess pedestrians' thermal comfort, and with what methods to quantify their sensation. At this point, it is important to repeat that the thermal sensation and satisfaction of outdoor users is basically a resultant response to a combined effect of the abovementioned factors intertwined together, i.e., it is not merely due to single factor. This is "because the body does not possess individual sensors for each factor and consequently feels the thermal environment as a whole" (Toudert, 2005: 41).

Therefore, thermal comfort indices have been developed on the same basis; several factors are incorporated into a single equation that reflects "the simultaneous effects of two or more variables on the sensory and physiological responses of the human body and describe the state of human comfort" (Alznafer, 2014: 50).

So far there are more than 100 indicators for measuring thermal comfort and thermal stress (Nikolopoulou, 2011: 1553). Originally, the majority of these were designed to estimate thermal comfort in indoor settings. Later, as assessing outdoor thermal comfort has increasingly become a research interest, the need has grown to develop dedicated methods fulfilling the requirements of the outdoor environment. Thus, some indoor indices have been adapted and become popular for the outdoor context, while others have been developed specifically for outdoor use (Alznafer, 2014). In both cases, indices can generally be classified into two groups, according to Toudert (2005):

A. Empirical indices (e.g. ET, RT, WCI)[17] have been employed primarily to measure "simplified relationships that do not necessarily follow theory" and rely on a "combined effect of air temperature, air humidity and air speed on people in sedentary activity" (Toudert, 2005: 41). However, Alznafer (2014) points out that the major drawback of this group hindering its wide applicability outdoors is the neglect of the influential role of human-based factors (e.g. level of activity and clothing, and physiological and personal data, such as age, gender, weight, etc.).

B. Rational indices (e.g. ET*, SET*, OUT-SET*, UTCI, PET)[18] are more oriented toward assessing thermal conditions based on the body's heat balance, expressed in (°C) and are commonly used in outdoor settings. Indeed, as studying outdoor thermal comfort has become more sophisticated over the years; some indices have been adjusted from indoor models or even developed specifically for outdoor use. For example, while the OUT-SET* was adapted from the SET* to account for solar radiation (Spagnolo & de Dear, 2003), the PET, devised by Höppe (1999) and the UTCI, used by the International Society of Biometeorology (2009) were developed from the outset for outdoor use.

The advantages and limitations of such indices and others, particularly the rational, have been extensively reviewed in other similar studies (e.g. Toudert, 2005; Epstein

[17] **ET:** Effective Temperature, **RT:** Resultant Temperature and **WCI:** Wind Chill Index.
[18] **ET*:** new Effective Temperature, **SET*:** Standard Effective Temperature, **OUT-SET*:** Standard Effective Temperature for Outdoor settings, **UTCI:** Universal Thermal Climate Index, **PET:** Physiological Equivalent Temperature.

& Moran, 2006; Monteiro & Alucci, 2009; Tseliou et al., 2010; Alznafer, 2014). However, the PET has been adopted in this thesis to evaluate the thermal environment objectively. This is because it has proved to be appropriate and reliable in outdoor settings by numerous studies, particularly under extreme conditions.

It is worth repeating here that the psychological state of a person plays an influential role in reflecting thermal comfort, as a result of activities being practised or the stimuli surrounding that person[19] (Nikolopoulou, 2004); however, it is an advanced factor to take into consideration. This postulate is especially true when the four basic environmental factors represent such serious challenges that they can cause heat stress, particularly if they have not been addressed through design interventions in the first place. In other words, it would be good to take the psychological factor into account, but where the climate and conditions are really awful; the other factors outweigh it anyway. Consequently, the physiological approach, by necessity, serves best under extreme climate conditions (Brager & de Dear, 2003), as in the case of Dammam. Hence, the PET index is employed in the study and is discussed in detail in the following paragraphs.

3.3.6.1 Physiological Equivalent Temperature 'PET'

The PET has increasingly become a preferred thermal index in outdoor thermal comfort studies to evaluate the state of thermal comfort objectively. This growing interest is owing to the proven higher accuracy of PET over the use of other thermal indices, as reported by several studies (e.g. Matzarakis et al., 1999; Deb & Ramachandraiah, 2010; Lin et al., 2013; Alznafer, 2014; da Silva & de Alvarez, 2015; Algeciras et al., 2015). Some of the advantages PET provides which support its adoption in the study include:

- It is a single and universal thermal index which uses a system of equations enabling the calculation of all thermoregulations of the human body, including heat flows, actual body temperatures and sweat rate;

[19] For example, in the case of a person watching parades, events and activities of outdoor exhibitions and carnivals compared with the same person in the same place without being exposed to such activities and stimuli.

- It is very effective for assessing pedestrians' thermal comfort because it considers levels of physical activity and value of cloth resistance in its calculations along with the four basic environmental factors;
- It is an analytical tool which facilitates correlating the collected meteorological data with pedestrians' responses to thermal comfort questions, and hence gives a real representation of the sensation of climate by outdoor users;
- it is measured by a well-known universal unit (°C) which makes results more understandable by general public, as well as urban designers and landscape architects;
- It can be used efficiently for the assessment of thermal comfort in indoor and outdoor settings as well as in hot and cold conditions; and
- It is comparable, so that the results of this study can be compared with PET values from other studies.

The PET index was first introduced to describe the thermal environment at any given place, especially outdoors, in a thermo-physiologically weighted way (Höppe, 1999). Thus, it is defined as the air temperature at which in a typical indoor setting [where Tmrt = Ta; water vapour pressure (VP) = 12hPa (≈ RH 50% at Ta = 20°C); v = 0.1m/s; light activities or equal to 80 Watt (W) are added to basic metabolism; and clothing resistance = 0.9clo] the body's heat balance is maintained with the core and skin temperatures, as in the actual outdoor condition (Matzarakis & Amelung, 2008; Matzarakis et al. 2010).

In other words, the PET enables an outdoor user to compare physiologically the thermal conditions at any outdoor space with his/her own thermal experience in a typical indoor space in which his/her heat balance is maintained with the core and skin temperature (Lin et al., 2013; Alznafer, 2014). For instance, a person with 43°C PET outdoors will have the equal thermo-physiological status of a person in an indoor environment with air temperature of 43°C (Höppe, 1999). This is because the PET is estimated by using the Munich Energy-balance Model for the Individual (MEMI), which takes into account human thermoregulation.

According to Alznafer (2014), the MEMI relies on all relevant heat flows that take into account the core temperature, skin temperature and clothing surface temperature.

As illustrated in Figure 3.6, some of the heat flows mentioned in Equation 1 are directly influenced by the meteorological parameters, although to varying degrees. For instance, the mean radiant temperature (Tmrt) affects only the net radiation of the body (R), while both air temperature (Ta) and wind speed (v) affect the value of the convective heat flow (C). Simultaneously, the Ta and relative humidity (RH) can influence the sum of heat flows for heating and humidifying (E_{RE}). On the other hand, while the rate of the latent heat flow (ED) is only influenced by RH, the heat flow due to evaporation of sweat (E_{SW}) is influenced by both the RH and v.

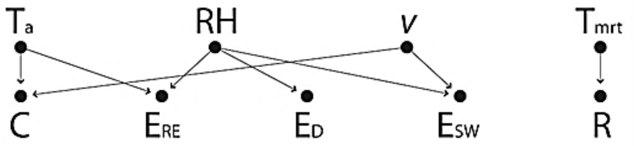


Figure 3.6 Effects of the environmental parameters on the physiological state of the human body (Source: Alznafer, 2014: 53)

Therefore, all the variables found to influence the body's heat balance are necessary for calculating the PET. This includes values of Ta, RH, v and Tmrt, along with the thermo-physiological parameters including clothing thermal resistance value (clo = 0.9) and metabolic rates (Met = 80W). In addition, Matzarakis et al. (2010) identify the surrounding environment as divided into two hemispheres, upper and lower, where the parting plane locates at approximately 1.1m above ground level. This height, which represents the mean gravity centre of an average person, forms the reference level for thermal comfort studies (Moustris et al., 2013; Alznafer, 2014; Algeciras et al., 2015). This means any microclimatic data measurements need to be placed around this height (Lin et al., 2013; 2014).

Of particular importance here is to clarify that the mathematical calculations of thermal indices, including PET, have always been the focus of researchers' attention, due to the complexities involved in such a process. Therefore, supported by the recent progress in computing techniques, several online designated software applications have been developed to facilitate this task. Among the increasingly used models to calculate the PET is the ***RayMan*** model. The model was transformed into free available software by its author: *Andreas Matzarakis* (Matzarakis et al., 2007; 2010). Accordingly, all mathematical complications can be avoided, as the PET can be easily calculated in one run, based on the input parameters, i.e. environmental, thermo-physiological and personal factors, in addition to others such as cloud cover. Thus, RayMan was utilised in this study to analyse the collected data *in situ*, in order to identify pedestrians' thermal comfort range.

Furthermore, comfortable thermal conditions vary by season, activities and geographical context (Carmona et al., 2010). Given that each region has a different climate reality owing to the prevailing meteorological conditions, outdoor users have different thermal acceptable ranges and preferences, even under the same climate conditions. For example, Lin and Matzarakis (2007) found that outdoor thermal comfort in Asia is higher than that in Central Western Europe. The same authors and others, in 2008 and 2014, in a comparative study between Portugal for the Mediterranean and Taiwan for the subtropics found significant differences exist between both regions, and hence, different thermal comfort ranges.

Thermal comfort studies usually aim to identify the upper and lower limits within which people feel comfortable in outdoor spaces (Algeciras et al., 2015). Thus, it is always fruitful to review some studies that have utilised the PET in different climates for comparison purposes.

Table 3-6 shows comparison of the thermal sensation and PET ranges for outdoor users in selected climates. For instance, the acceptable thermal range in the ***temperate*** climate of Central/Western Europe was found to be 18-23°C PET (Matzarakis & Mayer, 1996) and the upper comfort limit in ***subtropical*** Sydney Australia was 24.8°C PET (Spagnolo, & de Dear, 2003). In ***hot-humid*** regions, some researchers seem to have got rather different results; such as in Taiwan, it was 26-30°C PET (Lin & Matzarakis, 2008), 21.3-28.5°C PET (Lin, 2009), 27-29.4°C PET in south Taiwan (Lin et al., 2013), 26.3-31.7°C in Singapore (Yang et al., 2013) and 22-30°C PET in a coastal city in Brazil (Algeciras et al., 2015). While the upper comfort limit in ***hot-arid*** Riyadh Saudi Arabia was 38.8°C PET (Alznafer, 2014).

Table 3-6 Comparison of PET values between different climates (Source: the author)

PET Location		Central/ Western Europe	Sun Moon Lake, Taiwan	Riyadh, Saudi Arabia	Vitória, Brazil
climate type		*Temperate*	*Hot -humid*	*Hot -arid*	*Hot -humid*
Author(s)		(Matzarakis & Mayer, 1996: 8)	(Lin & Matzarakis, 2008: 286)	(Alznafer, 2014: 123)	(da Silva & de Alvarez, 2015: 69)
Thermal sensation	Very cold	≤ 4°C	≤ 14°C	-	-
	Cold	4 < PET ≤ 8°C	14 < PET ≤ 18°C	-	18 < PET ≤ 20°C
	Cool	8 < PET ≤ 13°C	18 < PET ≤ 22°C	-	-
	Slightly cool	13 < PET ≤ 18°C	22 < PET ≤ 26°C	-	20 < PET ≤ 22°C
	Neutral	18 < PET ≤ 23°C	26 < PET ≤ 30°C	36 < PET ≤ 39°C	22 < PET ≤ 30°C
	Slightly warm	23 < PET ≤ 29°C	30 < PET ≤ 34°C	-	30 < PET ≤ 34°C
	Warm	29 < PET ≤ 35°C	34 < PET ≤ 38°C	39 < PET ≤ 46°C	-
	Hot	35 < PET ≤ 41°C	38 < PET ≤ 42°C	46 < PET ≤ 50°C	34 < PET ≤ 46°C
	Very hot	> 41°C	> 42°C	> 50°C	> 46°C

The underlying reason for such a noticeable increase in the comfortable PET values from the temperate to hot regions can be attributed to outdoor users in hot climates are more likely to be physiologically and physically adapted to high temperatures and have a high degree of control over discomfort sources (Nikolopoulou & Steemers, 2003). In addition, the higher comfortable PET value under hot-arid conditions than in a hot-humid climate can be attributed to the fact that the human body in arid climates achieves a higher rate of heat dissipation, through sweat evaporation, compared to that under humid climate (Szokolay, 2014).

3.3.7 Methods of Measuring Urban Microclimate and Assessing Pedestrians’ Thermal Comfort

At first, it should be repeated here that the primary interest in this chapter, and the whole thesis, is at the pedestrian scale of the street space. This means the physical and spatial characteristics, because any “variation in spatial configurations of public spaces may cause significant differentiation of the microclimatic parameters, such as radiant temperature, relative humidity, and wind speed” (Vasilikou & Nikolopoulou, 2014: 103).

Consequently, taking account of the geometry of urban street canyons has become an accepted approach either to examine its impact on outdoor thermal comfort or to simulate micro-meteorological variables. Such studies primarily focus on (a) the aspect ratio of buildings’ height to street width (H/W) and (b) street orientation

(Alznafer, 2014). In this context, according to Toudert (2005) and Toudert and Mayer (2006), the PET under a hot-arid climate in E-W oriented streets with H/W ratio = 4 can be as low as a value close to the air temperature. This ratio is considered optimal, as it provides the longest period of shade compared to H/W = 0.5, 1 and 2. Nevertheless, this approach has not been taken into further review.

This is because the focus in this thesis is on a hot and humid climate, which necessitates different urban design considerations such as "dispersed buildings to allow for easy flow of wind through the spaces" (Nikolopoulou et al., 2001: 227). Turner puts further emphasis on urban design in hot-humid climates, saying designers "should strain every ear to catch the wind" (Turner, 1996: 103). Accordingly, streets often become shallow canyons; thus "implementing shading strategies at street level (galleries, trees, etc.) is the only way to improve substantially the human thermal comfort" (Toudert & Mayer, 2006: 49).

Accordingly, the real challenge to achieve a thermally comfortable ambience on urban streets in hot-humid contexts – for restoring pedestrians into the street space – is on the small scale at the pedestrians' level. In this context, Gehl (2010) repeatedly emphasises that successful urban designs are the practices that pay careful attention to how to combine the new challenges with respect for human scale. In regard to the design of urban streets, he further demonstrates that to encourage "people to walk and bicycle in cities as part of their everyday routine" providing what qualities they need "on the small scale – at eye level – is crucial" (Gehl, 2010: 115). In support of this approach to achieve outdoor thermal comfort; although he does not mean to ignore or downplay the significance of urban geometries, Gehl asserts that:

> "If the invitation to walk and bicycle in cities is to be genuine, and if people really want to be inspired and invited to take their time in the city, then microclimate at eye level must be as optimal as possible" (Gehl, 2010: 175).

Above and beyond that, whatever the scale being used in any thermal index (e.g. PMV value of +2 or 49°C PET) would be meaningless, because it does not reflect, if used separately, the actual degree of human sensation or state of comfort towards the surrounding conditions; "unless comparison with social surveys is carried out" (Toudert, 2005: 49). Accordingly, many of the outdoor comfort studies typically employ the questionnaire technique, which is presented below.

It is worth mentioning that other studies, although beyond the focus in this study, have utilised a combination of methods, such as incorporating observing the effects of shading, mainly by means of trees, on the microclimate conditions and consequently on thermal comfort (e.g. Johansson & Emmanuel, 2006; Mayer et al., 2009; Lin et al., 2010; Hwang et al., 2011; Lin et al., 2013; Konarska et al., 2014, 2015). Others have further utilised 3D modelling techniques, such as ***Envi-Met*** for simulating micro-meteorological variables, to predict the impacts of various geometrical configurations of street canyons on urban microclimates, and thus on thermal comfort (e.g. Toudert & Mayer, 2006; Alznafer, 2014; Sharmin & Steemers, 2015; Taleghani et al., 2015)

***(A) Questionnaires*:** these are always utilised to assess the impact of micro-meteorological variables on thermal perception, satisfaction and preferences of outdoor users. Typically, this method is conducted in a face-to-face interview, simultaneously, while measuring microclimatic conditions *in situ*. Doing so enables researchers to correlate pedestrians' thermal sensation vote with the actual measurements of micro-meteorological variables. The purpose of such a procedure is to explore the microclimatic conditions responsible for defining outdoor thermal comfort boundaries (i.e. upper/lower limits) at the pedestrian level (e.g. Aljawabra & Nikolopoulou, 2010; Lin et al., 2014; Alznafer, 2014; da Silva & de Alvarez, 2015).

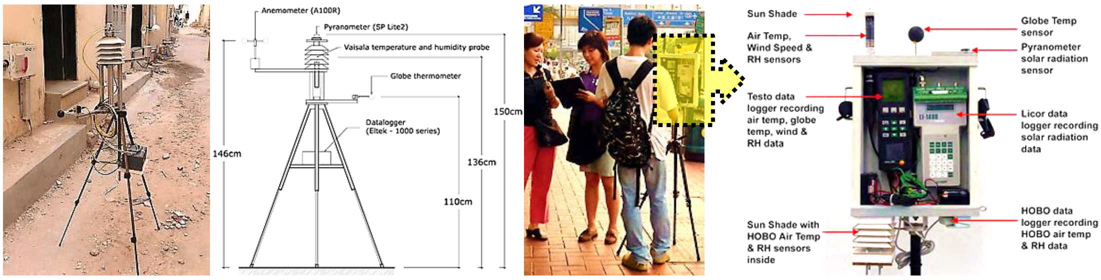
The method measures the thermal perception of outdoor users by allowing the participants to select their preferences or ratings for each of the four environmental parameters, through closed-ended questions. Measuring the Ta is mainly based on seven-point scale ranges from cold (-3) to hot (+3), as recommended by ASHRAE (2009). For gauging preferences to the RH, v and shading levels, Alznafer (2014) confirms it is more convenient and practical to use a scale of [prefer less – no change – prefer more].

The questionnaire also takes into account the personal factors found to influence thermal comfort and essential for calculations of thermal indices. Such factors include: gender, age group, height, weight, clothing insulation, level of physical activity and food/drinks consumption. Identifying and documenting the previous environment (indoor/outdoor) for every participant within the last 15 minutes prior to participation is also important, as recommended by ASHRAE Standard (2004).

***(B) Methods of urban microclimate measurements*:** the literature review reveals several methods have been commonly utilised in outdoor comfort studies for collecting the necessary micro-meteorological data, which can be grouped into two sets: continuous and instantaneous. These are (a) continuous micro-meteorological monitoring stations mounted on fixed structures such as a T-shaped mast or buildings (Figure 3.7); (b) mobile stations on a tripod stand (Figure 3.8), two-wheeled hand-drawn buggy (Figure 3.9) or vehicle-mounted (Figure 3.10); (c) portable mini weather station (Figure 3.11); (d) portable microclimatic sensor array worn on the head (Figure 3.12); and (e) handheld microclimatic data meter (Figure 3.13).

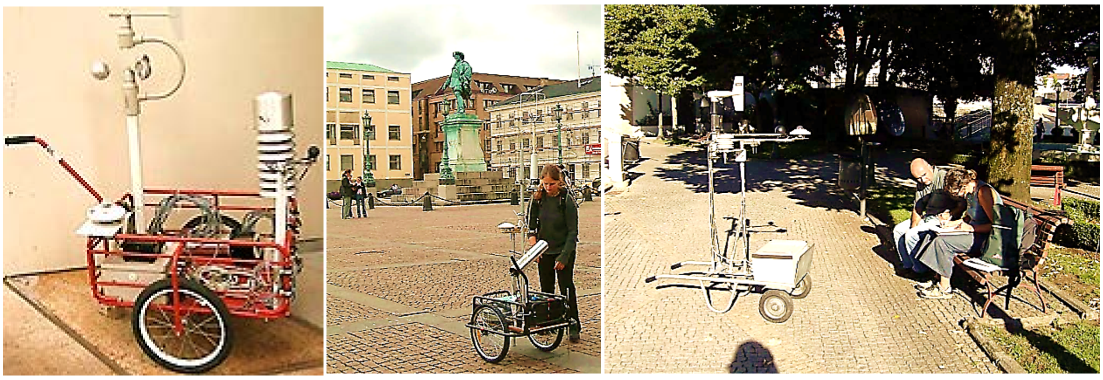
In this context, recent outdoor thermal comfort studies require careful selection of micro-meteorological instruments, and hence recommend the use of a portable/mobile environmental device that is easily transported around, reliable and fast-reading (e.g. Nikolopoulou & Lykoudis, 2006; Aljawabra & Nikolopoulou, 2010; Lin et al., 2014) and preferably lightweight (Alznafer, 2014). Accordingly, among the five types stated above, only the last two methods receive further evaluation in this review. This is due to the fact that both devices are found to appropriate to the dynamic nature of the case-study areas and the overall data collection methods adopted in the study, as well as being relatively more compatible with socio-cultural concerns in Saudi Arabia; hence they are reviewed below.

Figure 3.7 Climate sensors mounted on T-shaped mast attached to buildings (Source: Alznafer, 2014: 146)



A. (Source: Alznafer, 2014: 109)　　B. (Source:Cheng & Ng, 2008: 225)

Figure 3.8 Mobile micrometeorological measurement stations on a tripod stand



A. (Lenzholzer, 2008: 188)　　B. (Eliasson & Thorsson, 2008: 83)　　C. (Gonçalves et al., 2008: 263)

Figure 3.9 Micrometeorological measurement stations carried on a two-wheeled hand-drawn trailer buggy

Figure 3.10 Vehicle-mounted micro-meteorological measurement stations (Source: Gonçalves et al., 2008: 253)

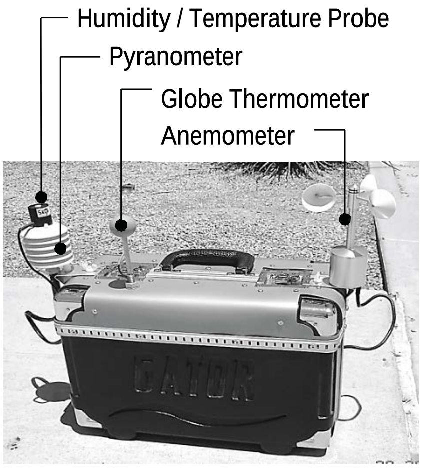


Figure 3.11 Portable mini weather station (Source: Aljawabra & Nikolopoulou, 2010: 202)

The first method for detailed review is the ***portable sensor array***, which was constructed for outdoor use by Potvin (2004) after a similar device had proved its success indoors in a study by Baker and Standeven (1994). Despite the advantages of this device; for example, being hands-free for the researcher to do other activities, due to its design to be worn on the head similar to a stereo headset, and being a lightweight device, it has several drawbacks discouraging its adoption for the study:

(a) The sensor array is not an accessible or a commercial device, hence a person with advanced engineering skills is needed to build it up;

(b) This device was designed from the outset to be worn on the head of the researcher alone while he or she "moves constantly, so as to recreate pedestrian movement in the urban realm" (Potvin, 2004: 129). Therefore, it is mainly an objective method and has nothing to do with measuring the actual experience and sensations of pedestrians;

(c) In connection with the latter point, given that the Saudi national costume comprises wearing headgear (see Appendix D.2); placing anything odd on the head is more likely becomes eye-catching and may interfere with fieldwork activities;

(d) If it was possible to this device to be used by others, then it would be necessary to assemble more devices. In this case, regardless of the cost, effort and time, the use of this technique could be effective and useful only if the focus-group method is adopted, where each group (or members within the group) can be given one device to be collected after completion; and

(e) The device lacks GPS capability, hence, if it was given to someone other than the researcher, any climatic conditions recorded through the attached data logger could not be easily linked to its geographical location for analysis and correlations.

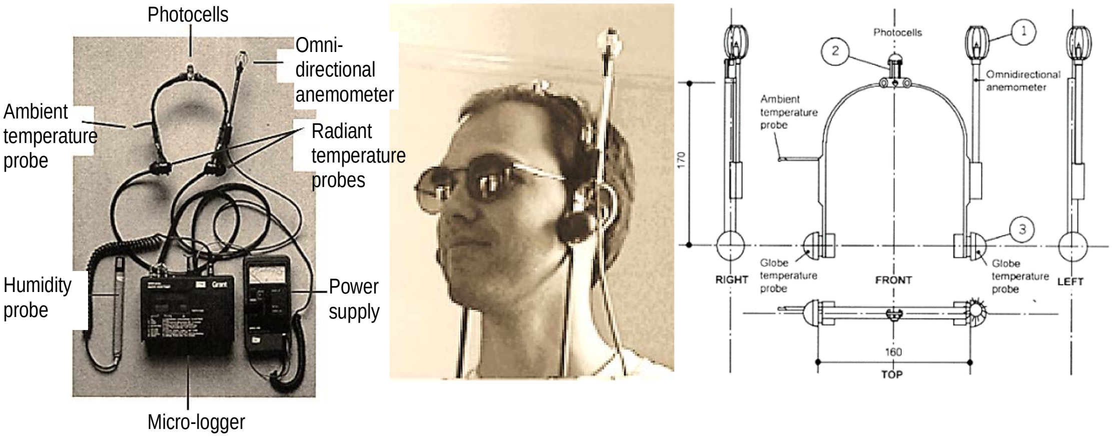


Figure 3.12 Overhead portable sensor array (Source: Potvin, 2004: 128)

The second method is the ***handheld device*** (Figure 3.13) that was utilised in a recent study (Alznafer, 2014) which proved the use of such a device to be reliable. It is a relatively a small-sized and portable meter that looks almost identical to a modern mobile phone. These properties are of great importance in situations where the avoidance of attention towards the researcher by the public is essential.

This instrument is specifically designed to measure Ta, RH, v and Light intensity (lux). Nevertheless, one downside of the device is the lack of a built-in sensor for measuring the globe temperature (Tg) or mean radiant temperature (Tmrt), although the latter cannot be measured or calculated directly, unless the former factor has been made available (Szokolay, 2014).

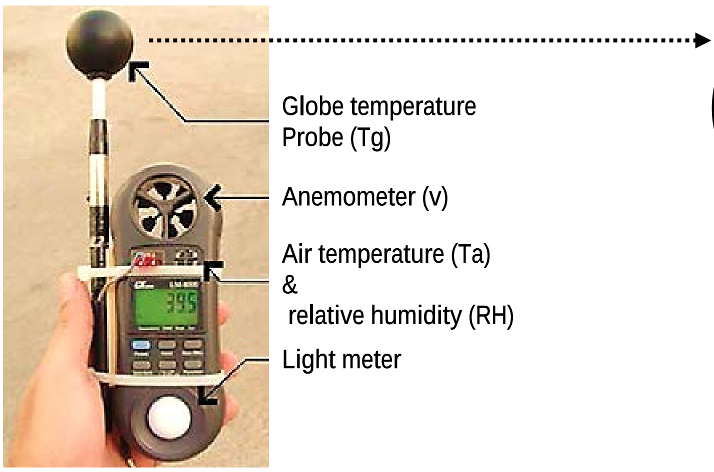


Figure 3.13 Handheld microclimate Meter (Source: Alznafer, 2014: 92)

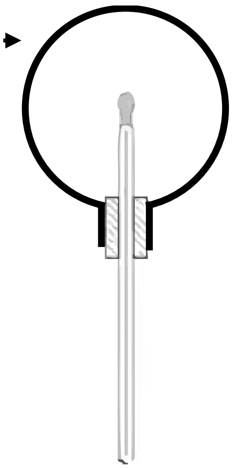


Figure 3.14 Illustration of the globe thermometer (Source: Szokolay, 2014: 17)

In this context, a considerable number of studies emphasise the importance of estimating the Tmrt when assessing outdoor thermal comfort, particularly under sunny conditions (e.g. Hoppe, 1992; Spagnolo & de Dear, 2003; Thorsson et al., 2007; Ng & Cheng, 2012; Tan et al. 2013; Szokolay, 2014; Parsons, 2014). In addition, it is an essential variable for calculating the PET. Typically, according to ASHRAE (2009), estimates of the Tmrt can be calculated through the measured Tg, Ta and v, using Equation 2. Although the handheld device is mainly designed to measure the required Ta and v, it is capable of measuring the Tg by connecting an external globe temperature probe through the built-in Type K thermocouple input socket (Alznafer, 2014).

Therefore, the basic approach would suggest attaching the standard globe thermometer that "responds to radiant inputs as well as to air temperature" and consists of "a 150 mm diameter copper ball, painted matt black, with a thermometer at its centre" (Szokolay, 2014: 17) "and a thickness of 0.4 mm" (Alznafer, 2014: 111) (Figure 3.14). By this spherical shape, the Tg, and thus Tmrt, "will not depend on its orientation in the surroundings" (Parsons, 2014: 17). However, the 150mm ball has three major issues hindering its use with the handheld instrument. (a) Auliciems and Szokolay (2007: 8) indicate that the 150mm copper ball takes up to 15 minutes to reach thermal equilibrium; (b) Alznafer demonstrates that such a "thermal state will be never achieved if the air speed or ambient temperature change over the time, such as of that in outdoor environments" (Alznafer, 2014: 111); and (c) the weight and size of the copper ball not compatible with the device size.

To avoid such limitations; "It is common, for convenience and in commercially available instruments, to use a smaller globe size than 150 mm diameter" (Parsons, 2014: 450). This simple and low cost approach has been recently adopted to measure the Tg using "matt black painted ping pong balls" which provides the same effect as the 150mm copper ball (Szokolay, 2014: 17)[20]. Indeed, "the specification will not change but a method is provided for calculating 150 mm-diameter globe temperature from globe temperatures for different sizes of globe" (Parsons, 2014: 450).

[20] See section 7.4.3 regarding the limitations to the use of a black or grey painted ball for measuring the Tg.

Accordingly, the Tmrt can be estimated from calculating the measured Tg (obtained from a matt black 38mm[21] globe thermometer attached to the handheld device), Ta and v based on the following equation, adopted from ASHRAE (2009):

$$Tmrt = ((Tg + 273.15)^4 + ((1.1\times10^8\, v^{0.6}) / (\varepsilon D^{0.4}))\, x\, (Tg - Ta))^{1/4} - 273.15 \quad \textbf{Equation 2}$$

where *Tg* is the globe temperature (°C); *Ta* is the air temperature (°C); v is the wind velocity (m/s); *D* is the globe diameter (mm); and (ε) is the globe emissivity.

3.3.8 Methods of Urban Microclimate Improvement at the Pedestrian Level

After reviewing some of the issues most associated with outdoor thermal comfort, it is worth presenting some design interventions that have proved effective in modifying the urban microclimate. Hence, to enrich this literature review and not to be simply descriptive, the following paragraphs conclude this section of the chapter by focusing on such mitigation techniques – whether traditional or innovative – which are applicable at the microscale of the street space in hot and humid areas.

Thus, for easing pedestrians' heat stress, landscape architects and urban designers "need to provide comfortable conditions within public spaces – comfort being a prerequisite of successful people places" (Carmona et al., 2010: 226). However, "it is inadequate to design open spaces with regard to thermal comfort solely [...] The physical environment is important in outdoor thermal comfort" (Nikolopoulou, 2004: 117) because any "change in one aspect or quality of the environment, inevitably affects our response to, and perception of, the whole environment" (Vasilikou & Nikolopoulou, 2014: 102). Without being deterministic, design actions can largely help to make outdoor thermal conditions more acceptable at the pedestrian level. In support of this postulate, Hebbert and Jankovic argue that:

> "Climatically responsive urban design requires local investigation. Generic environmental measures [...] go so far but like oral medicine in a human body they may not touch the spot. Cities are spatial entities and effective medication sometimes needs to be topical, applied just where it matters" (Hebbert & Jankovic, 2011: 14).

[21] According to Johansson et al. (2014: 350), this was the diameter of a standard Ping-Pong ball, which was changed into 40mm in the year 2000. However, some countries are still using the 38mm size.

In this vein, Gaitani et al. (2007) argue that design interventions at the microscale should be given highest priority in designing urban spaces, in order to enhance the urban microclimate and thus increase conditions of thermal comfort, especially in hot areas. However, micro-meteorological variables, although they are integral components of urban design owing to the great impact they create upon outdoor users' experience and their use of urban spaces, often come at the end of the designers' priorities (Carmona et al., 2010; Hass-Klau, 2015).

Multiple design solutions at the pedestrian level, mainly from hot climate contexts, prove potentiality to cope with prevailing microclimate conditions and thus to achieve a thermally acceptable ambience on urban streets. This can be achieved by employing individual or a combination of urban design strategies, such as:

(a) Reconfiguring the physical and spatial characteristics of the street space for incorporating shading techniques such as trees, canopies, pergolas or arcades. (Toudert & Mayer, 2006; Carmona et al., 2010; Gehl, 2010; Lin et al., 2010; Hwang et al., 2011) and wind capture (Masdar City, 2013);
(b) Maintaining low building density to reduce thermal emissions associated with highly populated urban areas (Alznafer, 2014) and increasing the distance between tall buildings to accelerate the process of heat loss (Al-Saud, 2006);
(c) Increasing the use of urban surface materials with thermal properties of high albedo[22] and/or emissivity[23] values (Oke, 2002; Al-Saud, 2006; Lin et al., 2007);
(d) Increasing the ratio of urban trees alone, for shading (Al-Awais, 1991; Mayer et al., 2009; Lin et al., 2010; Hwang et al., 2011; Konarska et al., 2015), or together with high albedo surfaces (Al-Saud, 2006; Alznafer, 2014); or using both factors plus water features (Akbari et al., 1992; Robitu et al., 2006; Gaitani et al., 2007).

All the above measures have great impacts on the reduction of urban heat stress and are highly recommended for three particular purposes in hot regions: (a) to minimise

[22] It is the ability of materials' surfaces to reflect incoming solar radiation in urban environments by using light colours.
[23] Emissivity is a measure of the efficiency of a material's surface in emitting energy as thermal radiation. Depending on the material (wood, concrete, metal), nature of the surface (polished, rough, oxidised), temperature of the surface, wavelength and angle; materials can have emissivity values from 0 (perfect reflector - mirror) to 1 (perfect emitter - blackbody) (NPL, 2014).

the severity of urban micro-metrological variables; (b) to reduce urban heat storage; and (c) to reduce effects of the Urban Heat Island phenomenon (UHI[24]). In terms of the controllable factors, Figure 3.15 shows how the Ta, RH, v and Tmrt, as the most influential factors on pedestrians' thermal comfort (Setaih et al., 2013; Alznafer, 2014), can be improved by design interventions to attain better conditions of outdoor thermal comfort.

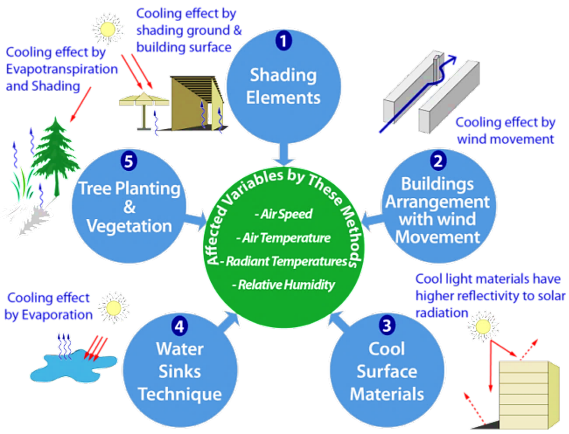


Figure 3.15 Methods of urban microclimate improvement through design interventions & their cooling effects at the pedestrian level (Source: Setaih et al., 2013: 3155)

(1) Street Shading Techniques: probably nothing is more important to pedestrians' thermal comfort in outdoor spaces in hot climates than the crucial need to provide protection from solar radiation load (whether direct or reflected) and air temperature. Although designers' ability to control outdoor air temperature maybe very limited, it can be fairly simple to control exposure to the sun (Erell et al., 2011a: 148). Furthermore, while a sunny side of the street is accepted as a desirable quality to encourage its use by the different types of pedestrians in cold and temperate regions, shaded streets are far beyond just being a supplementary requirement in hot areas.

Providing shade for an urban street is a fundamental necessity to ensure its use, otherwise pedestrians would withdraw to alternative indoor environments (Jaber, 2013). Therefore, any attempt to restore pedestrians into the street space entails a shading strategy; whether natural or man-made, so as to promote radiative cooling

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[24] The UHI is the phenomenon of elevated air temperature in urban settings compared to rural areas, caused by a number of man-made factors, including (a) urban geometries; (b) thermal properties of urban surfaces; and (c) heat released from anthropogenic sources (Oke, 2002; Gartland, 2008; Rizwan et al., 2008).

that eventually affect the experience of pedestrians' thermal sensation (Nikolopoulou, 2004; Lin et al., 2010; Alznafer, 2014).

Hence, the first exemplary approach is to orient street layout in a self-shading way with respect to the direction of the sun movement. Northeast-southwest oriented streets have been found to provide the optimal shading in the Middle East, e.g. Ghodsi (2013) in Iran; Alznafer (2014), in Saudi Arabia. This is due to the shorter duration of exposure to solar radiation at the pedestrian level and lower PET maxima compared to other orientations, although this may conflict with the prevailing wind direction. The second concept is to adopt strategies of deep street canyons and compact urban form, or simply, restricting the width of a street – although it is seen as a fairly crude tool (Erell et al., 2011a: 149).

Nevertheless, these scenarios are often questionable in both hot-arid climates, because they increase the undesirable intensity of the nocturnal heat island (Alznafer, 2014), and in hot-humid climates, because they reduce easy flow of the desirable air movement into streets (Turner, 1996; Nikolopoulou et al., 2001). Therefore, dealing with existing conditions in a very hot and humid area; such as the one under study, the optimal approach is to implement alterations at the microscale to improve the microclimate (Gehl, 2010; Erell et al., 2011a). Supporting this point, Nikolopoulou et al. confirm that:

> "Shading whole streets is feasible whether in the form of trees, with the advantage of cooling via evapotranspiration through the leaves, or man-made canopies with the available materials, solutions found worldwide and not unique to specific cultures" (Nikolopoulou et al., 2001: 227).

Consequently, the following images present some of the practical shading techniques that are currently utilised in hot regions in, for example, the Middle East and Mediterranean region, and thus controlling solar radiation at the pedestrians' level. The simplest and low-tech approach is by means of canopies integrated at the street level of the adjacent buildings and along the pavements. The canopies are often made from lightweight materials, for example, textile fibres with high albedo values, particularly from cotton or sackcloth[25]. This concept is widely utilised in Egyptian cities and other North African countries to date (Figure 3.16), as well as in very limited cases in the Gulf countries (Figure 3.17).

Figure 3.16 Retractable canopies over a collector street in Cairo, Egypt, as an adaptable physical intervention to suit seasonal thermal comfort requirements (Source: the author)

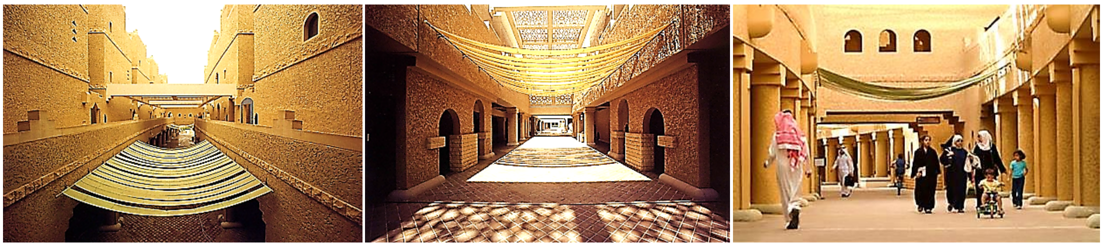


Figure 3.17 Canopies are effective contributors to moderate urban microclimate by providing shade essential for walking, Riyadh, Saudi Arabia (Source: Arriyadh Development Authority)

In this vein, the retractable overhead canopies have long been used to satisfy multiple uses of the street space (e.g. during social, cultural, marketing or religious events); as well as seasonal requirements for thermal comfort and even at different times in the same day (Nikolopoulou, 2004). Figure 3.18 shows a pedestrianized street in Malaga, a Spanish coastal city influenced by the Mediterranean climate; it is simply equipped with overhead fabric to provide protection from solar radiation during the day, yet retractable at sunset to cope with high humidity to better facilitate air movement.

[25] In the past, owing to efficiency of these materials to keep moisture longer than any other material, they were wetted with water allowing for any gentle breeze to cool the narrow street beneath whilst mitigating direct solar radiation.

Figure 3.18 Retractable canopies above the street space are an effective physical adaptation to satisfy requirements of pedestrians' thermal comfort on a daily and seasonal basis. Calle Marques de Larios pedestrian mall, Malaga, Spain (Source: www.alamy.com, 2013)

Moreover, the construction of arcades, whether as an integral part of the building or a light-weight add-on to it, is acknowledged among the long-established design solutions to provide shading (Erell et al., 2011a). They also serve as an intermediary environment where pedestrians have a choice that fulfils their thermal needs, and allow a gradual adaptation of their body to avoiding any overly abrupt environmental variation (Potvin, 2004). But arcades alone may not be sufficient to provide the acceptable protection; according to the sun's angle, and hence adding a supportive accessory becomes even more important (Figure 3.19).

Figure 3.19 Combining awnings, whether manual or automated, with arcades can further contribute in improving the street microclimate for pedestrians (Source: the author)

What is more interesting is when street design combines a variety of shading elements (Figure 3.20); e.g. trees, arcades, pergolas, overhead fabric and retractable awnings, the shading quality not only reduces the direct exposure of pedestrians to solar radiation, but also reduces surface temperatures. Consequently, urban microclimatic conditions are highly subjected to improvement, and correspondingly, pedestrians' thermal comfort (Erell et al., 2011b).

Figure 3.20 Integration of several shading methods often results in better effects than a single design intervention (Source: Erell et al., 2011b: 129)

Furthermore, a more advanced method, which has received several international awards, is the design solution introduced by Bodo Rasch[26] for shading the large external yards of the Prophet's Holy Mosque in Madinah City, KSA. Over 250 large convertible umbrellas cover almost the entire outdoor spaces (Figure 3.21). The distinctive features of this invention are represented in (a) its mechanical flexibility, so that it creates "a convertible roof without undermining the character of the mosque" (Nikolopoulou, 2004: 116); (b) the fact that it is fully automated, where the sensors activate the umbrellas under certain climatic conditions; (c) the umbrellas being slightly separated from each other to allow the hot air to dissipate smoothly; and (d) the fact that they fold back automatically at sunset to benefit from the nocturnal cooling.

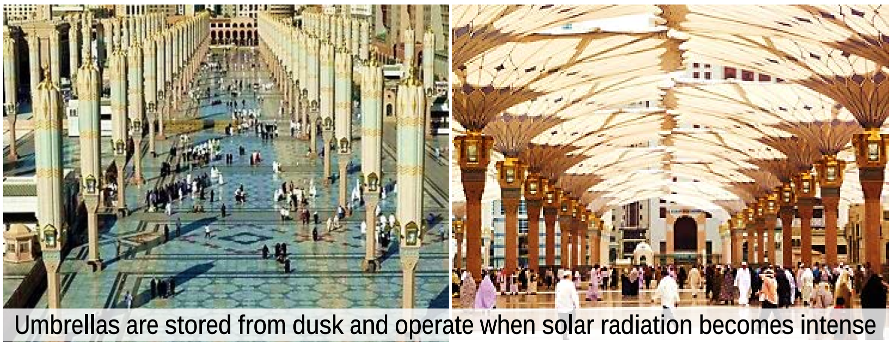


Figure 3.21 Convertible umbrellas, Madinah, Saudi Arabia

[26] A well-known contemporary German architect specialist in the design and construction of large retractable and convertible umbrellas.

(2) Increasing Air Movement Techniques: Understanding the characteristics of the wind velocity, flow and pattern within the street space is of prime importance in pedestrians' thermal comfort. Indeed, "When temperatures are close to human tolerance thresholds, every degree of mitigation matters" (Hebbert & Jankovic, 2011: 14). For this, in urban areas where there is no wind, the value of the outdoor thermal comfort index "is increased by 9-12°C […] means a rising discomfort during the summer season. Thus, the effect of wind velocity on the outdoor thermal environment is significantly large" (Murakami et al., 1999: 75).

Great importance is attributed to the cooling effects of wind in reducing the sensation of the severity of the microclimate conditions in hot areas, and becomes even more important in hot and humid areas, where the cooling breezes should be maximized (Erell et al., 2011a: 242). Accordingly, in such a climatic context air movement is a necessity to enhance conditions of thermal sensation. Successful urban streets; designed around air movement, can reduce the effect of hot conditions, as this can channel the wind direction and control its speed (Setaih et al., 2013; Alznafer, 2014).

However, when there is no wind or the velocity is low in urban spaces, active methods may become rational; although in limited spaces, if the aim is to provide acceptable ambience outdoors. A good example is the integration of revolving water-spraying fans (mist jets) onto the existing convertible umbrellas in the Prophet's Holy Mosque (Figure 3.22). The fans operate automatically by sensors under a certain degree of drought conditions. The yards have become more comfortable than before, where volume of users who prefer to stay longer has been increasingly observed (Yassin, 2012).

Figure 3.22 Mist fans at pedestrians' level in the Prophet's Mosque yards in Madinah

Nevertheless, the relevance of air movement to the use of urban spaces in very hot-humid areas becomes an even greater factor influencing outdoor thermal comfort (Szokolay, 2014). Therefore, modelled on traditional Arab designs for wind towers, 'Badgir', which have long been used in houses of the Gulf region, that suck air from above and pushes a cooling breeze to rooms below (Figure 3.23), in Masdar City – designed by the well-known British architect Norman Foster in 2007 – a unique wind tower has been invented specifically for outdoor use (Figure 3.24).

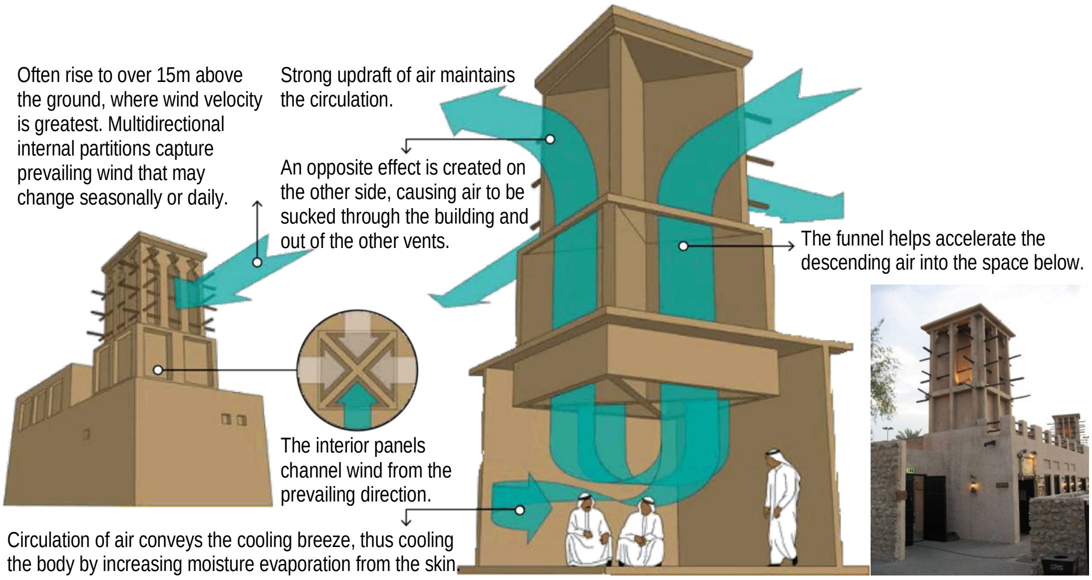


Figure 3.23 Illustrative diagram of the traditional wind tower in the Gulf region, its mechanism and effects (Source: EPFL, 2010)

This wind tower is a smart and modern ventilation method, rising 45m above the plaza in which it stands. Its height allows it to capture upper-level winds and direct them into the surrounding open spaces (squares and streets) at its base. Sensors at the top of the steel structure operate automated louvers to open in the direction of prevailing winds and to close in other directions to divert wind down the tower.

The PTFE (Teflon) fabric membrane carries the wind downward, while mist generators at the top spray water to cool the captured air. This passive combination of evaporative cooling and air movement has been found very effective in lowering the feeling of the temperature in the plaza and streets underneath. Thus, pedestrians have evidently become attracted to prolong their use of such places. Indeed, visiting the nearby open spaces to the tower is an unforgettable experience, compared to any other places in the region.

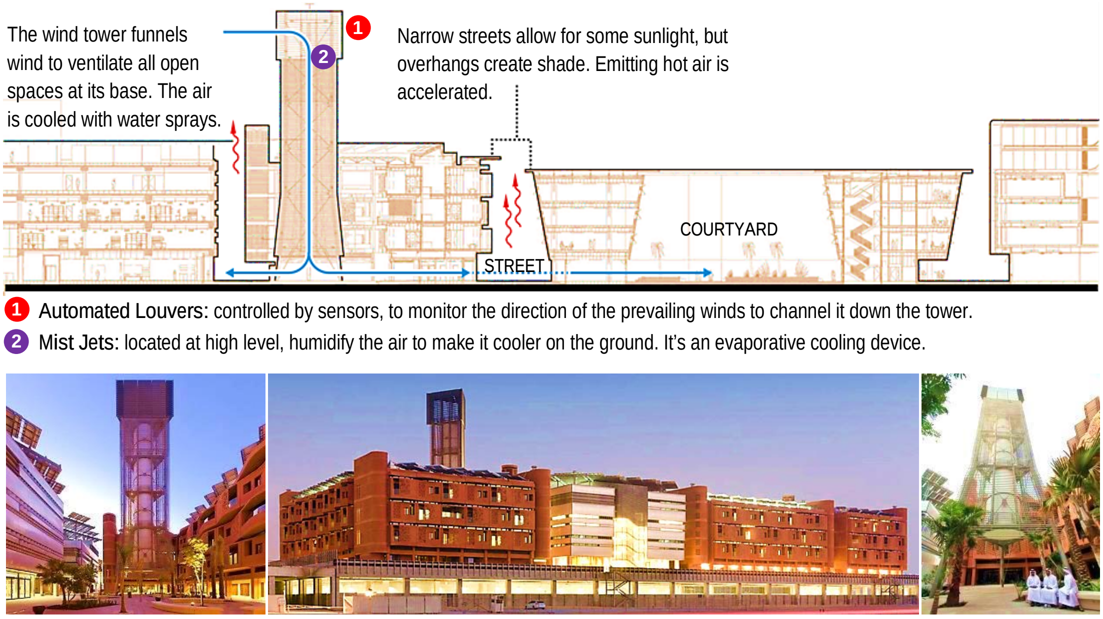


Figure 3.24 An invented model of the traditional wind towers in the Gulf region for urban spaces (Source: Masdar City, 2014; Foster & Partners, 2015)

(3) High Albedo Materials: The use of surface materials with high reflectivity values has proved an effective technique owing to their capability to dissipate a large portion of incoming solar radiation (Lin et al., 2007). Thus, it has been acknowledged as a promising technique to alleviate the effects of sources of thermal discomfort on pedestrians (Akbari et al., 1992; Fintikakis et al., 2011; Setaih et al., 2013; Alznafer, 2014). Specifically, research findings demonstrate that using light-coloured urban surface materials can reduce ambient air temperature, and hence improve thermal sensation (Levinson et al., 2007; Synnefa et al., 2008). This is attributed to the increase in reflectivity, which can cause a remarkable reduction in the temperature of the materials, by, at least, 10°C (Akbari et al., 2001; Synnefa et al., 2011).

In this context, the temperature of ground surfaces can show a large swing between day and night. For instance, paving stones are typically hotter than grass during the day but cooler at night, and the diurnal temperature of asphalt is hotter than concrete (Szokolay, 2014). Similarly, "Vegetation surfaces show lower radiative temperatures than other inanimate ones of the same colour. The difference in maximum temperature may exceed 20 K" (Shashua-Bar & Hoffman, 2000: 221). Accordingly, high surface temperatures can directly contribute to pedestrian discomfort by imposing both a large long-wave radiant load and high ambient air temperature. This may explain why a pedestrian walking on an asphalt surface may feel the ambience hotter than walking on a concrete surface (Erell et al., 2011a: 160-161).

(4) Water Features: in general, these represent one of the most effective natural/ passive cooling strategies or methods to mitigate outdoor air temperatures and to transfer heat stored in the surfaces, and hence help in improving pedestrians' thermal comfort levels in hot environments (Figure 3.25). Although thermally they may seem a discomfort source for climates with high humidity conditions, they can dissipate a portion of the heat gained from the hot conditions through an evaporative cooling system in urban spaces. Supporting this, Nishimura et al. (1998) found that incorporating such a method in hot-humid urban spaces in Japan was capable of dissipating part of the uncomfortable urban heat conditions experienced by pedestrians. Specifically, their findings – by introducing an artificial waterfall, spray fountain and water canal – revealed that a reduction in air temperature, reaching 11°C, was recorded, thus creating a better microclimate for pedestrians' comfort.

Indeed, "Evaporation and evapotranspiration are always associated with the heat transfer between water, vegetation and air" (Robitu et al., 2006: 440), thus "their presence improves the urban thermal environment in hot seasons by cooling the air and in easing the uncomfortable thermal environment" (Setaih et al., 2013: 3156).

A. Palm Springs, California B. Major walking track in Riyadh, Saudi Arabia

Figure 3.25 The use of water mist onto the pavement to mitigate the outdoor hot climate can enhance pedestrian comfort

(5) Street Trees: these are one of the most effective methods used to improve outdoor conditions for pedestrian thermal comfort in urban spaces of hot areas. Such a method can play a strong role in mitigating the urban heat gained from the sun (Dimoudi & Nikolopoulou, 2003), and hence modifying urban microclimates for enhancing outdoor thermal comfort, particularly under hot conditions (Mahmoud, 2011; Setaih et al., 2013). This is attributed to the dual cooling effect of trees resulting from the impact of evapotranspiration and canopy shading (Shashua-Bar & Hoffman, 2000; Fintikakis et al., 2011).

Indeed, the shade cast by trees can have multiple significant effects associated with solar radiation, for example, reducing surface temperatures of pavements, roads and buildings. Thus, in return, energy consumption from urban dwellings can be reduced (Alznafer, 2014), asphalt temperature is decreased (Aguiar et al., 2014), and the intensity of heat stress experienced by pedestrians is minimised, owing to the increased cooling effect (Al-Awais, 1991; Mayer et al., 2009; Konarska et al., 2014; Konarska et al., 2015). More specifically:

> “In a hot climate the shadow cast by trees can be a great relief. The surface temperature of a roof or of other hard surfaces can reach 70°C, but in the shade it may not go above 35°C” (Szokolay, 2014: 81).

Combining the impact of shading and trees in hot regions, the sky view factor (SVF) comes into play. The SVF is the portion of the visible sky above the observer, which is affected by H/W ratio as well as by volume of trees in urban areas. Thus, when a small portion of the sky is visible above pedestrians, it means the intensity of shading is high; when a large portion is visible or brighter, it indicates that amount of the solar radiation reaching the ground is high. Thus, increasing direct shading at the pedestrian level ensures low diurnal SVF which causes “a reduction in reflected radiation” because thermal comfort is “not only based on temperature, but also significantly on radiative exchange” (Ratti et al., 2003: 57).

(6) The Integration of Multiple Urban Microclimate Improvement Methods: Worth highlighting here, before closing this section, is to emphasise that Masdar City aims to create pedestrian-and-cyclist-friendly outdoor spaces by relying on multiple design interventions. Basically, the city design has adopted some of the planning principles of the traditional Arab settlements combined with cutting edge technologies. Specifically, these are: (a) short and narrow streets; (b) asymmetrical configuration and orientation of open spaces and building heights; (c) shading techniques, including vegetation and landscaping; (d) materials with high albedo, including the avoidance of asphalt; and (e) the unique design of the wind tower to create air movement.

While criteria a) and b) were found to be creating enough wind turbulence to push hot air upwards, thus creating a flushing effect that cools the street, the other components have been remarkably recognised to decrease the Ta and Tmrt. By utilising a thermal imaging camera for the purpose of comparison between a typical street in central Abu Dhabi and a street in Masdar City on the same day and at the same time, it was found that there was a big difference in the radiant temperature.

The comparative image below, Figure 3.26, shows the radiant temperature at the pedestrian level of the open spaces, including streets, was observed to be 15 to 20°C cooler in Masdar than Central Abu Dhabi. This difference is a result of the adopted urban design strategies, collectively (Masdar City, 2010). More specifically, the temperature dropped from 55°C to 32°C (Alfaraj, 2014). The bright colours, in the image, represent the high temperature of urban surfaces and amount of thermal radiation, while the dark colours reflect coolness of the surfaces.

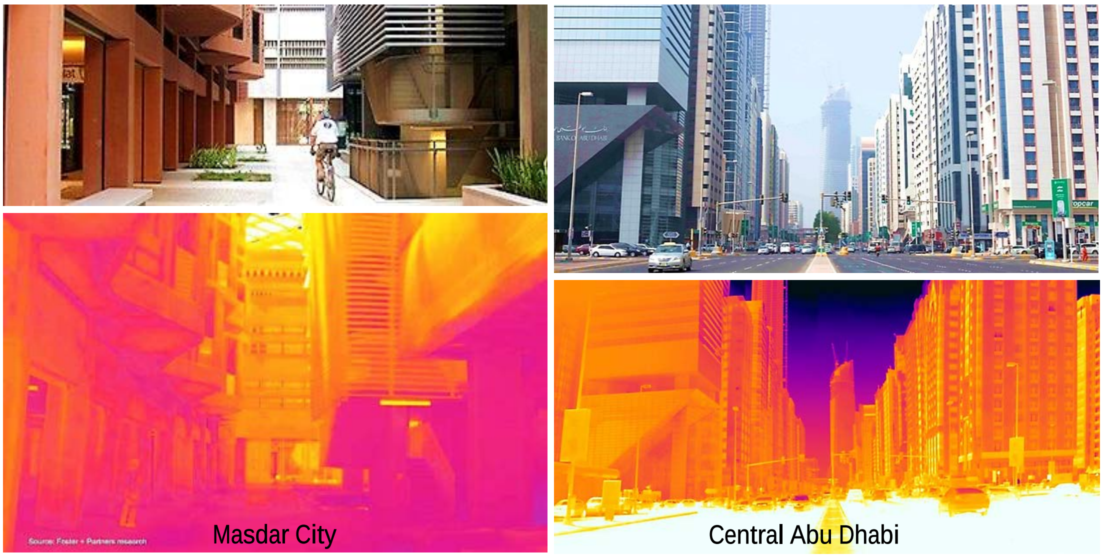


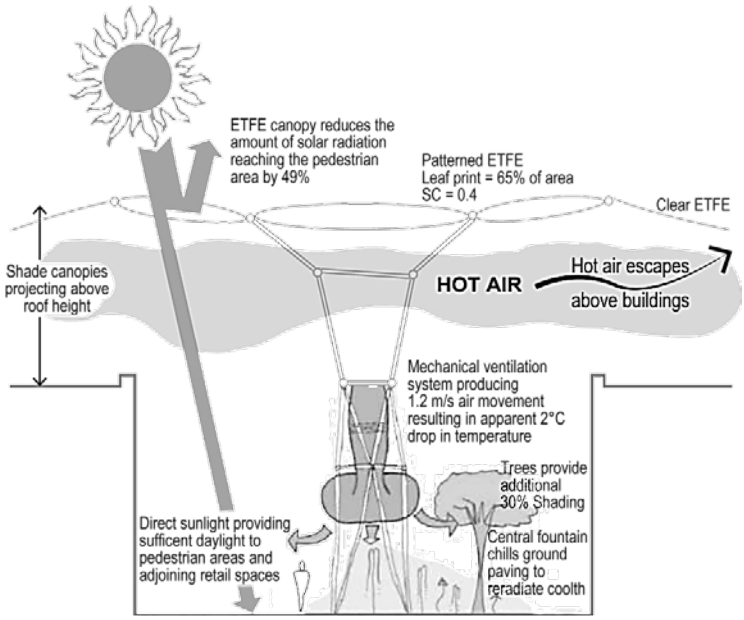
Figure 3.26 Thermal imaging comparison between a typical street in Central Abu Dhabi and in Masdar City demonstrating how climatically responsive urban design can cause a significant drop in radiant temperature from 55°C to 32°C (Source: Masdar City, 2010: 9)

Another good case study, which was designed for the same purpose[27], is the site of Clarke Quay, near the mouth of the Singapore River. Due to exposure of the site to a combination of high RH (averaging 87%) and warm Ta (an average maximum of 31°C) all year round, pedestrians exposed to the environment were feeling some level of discomfort at nearly all times. Under these conditions, a further development of the area was undertaken in 2006.

The overall concept of the design (Figure 3.27) was mainly based on the combined effect of shade (to reduce the effect of solar radiation), ventilation (to mitigate humidity) and the use of a fountain (to provide evaporative cooling). The integration of trees and light shading canopies, on one hand, in addition to air-flow at pedestrian level combined with evaporative cooling, on the other hand, worked effectively to provide thermally comfortable urban streets that promote their greater use throughout the year in such a hot-humid area (Erell et al., 2011a).

The adopted strategy relies on height of the canopies, which are constructed independently of the buildings and above roof-top height, to allow breeze to permeate the urban streets. This breeze is augmented by air blowers, which are installed into the structural frame of the canopies, to increase the air movement to generate the feeling of a natural air-flow at pedestrian level. These air blowers have been designed to provide an average air velocity of 1.2m/s along the streets. With this air velocity, there was a significant improvement of pedestrian thermal sensation throughout the streets. Additionally, the Tmrt, at standing height in and around the fountain, was reduced by 1.5 to 2K with the fountain running. Ultimately, the combined effect of the elements used in this design has contributed in reducing the ambient temperature by 4°C, and has successfully enabled the majority of streets to maintain 28°C (Erell et al., 2011a).

[27] The ultimate goal was to modify the microclimate of the existing streets and squares – which their design limited the opportunities to optimize the response to orientation – so as to improve thermal comfort and thus to promote outdoor activities in these spaces (Erell et al., 2011a: 242).



Section through street shows the adopted elements, within street space and above roof height, to microclimate modification.

Aerial view shows arrangement of the canopies above streets in the Clarke Quay development.

Street view shows air vents and air blowers installed to supplement natural air-flow at street level by mechanical means.

Figure 3.27 The combined effect of natural and artificial elements used in Clarke Quay, Singapore, has successfully enabled to maintain thermally comfortable street space at 28°C (Source: Erell et al., 2011a: 241)

3.4 PART THREE: Pedestrians’ Behaviour in the Socio-cultural Context

3.4.1 Overview

Pedestrian behaviour research, in general, grew from the field of Environment-Behaviour Studies (EBS), which developed from the convergence of “two sets of complementary concerns, one in the professional disciplines of environmental design and the built environment [i.e. architecture, landscape architecture, urban design and urban planning], and the other in the socio-cultural and behavioural sciences” (Moore, 2004: 2).

The reason for the emergence of this field is due, on one hand, to the very limited attention that these environmental design disciplines were paying to “behavioural, social, and cultural factors, individual perceptions and preferences, group norms and dynamics, and cultural values and expectations in the planning and design of our human environment” (Moore, 2004: 2).

On the other hand, the socio-cultural and behavioural studies were contributing in a too narrow way to a social understanding of the physical environment (Moore, 2004). Consequently, “The history of research on pedestrian-behaviour in the context of urban streets is relatively short” (Tsao, 2007: 70), and hence there is a need to fill this gap to develop understanding of the reciprocal interaction between pedestrians, including the socio-cultural factors that govern their behaviour, and the physical spaces which they use and live in, to better the design of the built environment. For example, the architect Philip Johnson in an interview (cited in Whyte, 2009: 357) states that designers designed:

> “blocks in front of the Seagram Building so people could not sit on them. But, you see, people want to so badly that they sit there anyhow. They like that place so much that they crawl, inch along that little narrow edge of the wall. We put the water near the marble ledge because we thought they’d fall over if they sat there. They don’t fall over; they sit there anyhow”.

This, indeed, demonstrates that the lack of understanding of pedestrians’ behaviour – whether static or dynamic – and what they need in and for urban spaces can be an obstacle for designers in creating useable urban places where social life can be stimulated. Focusing on how the actual outdoor users will use the designed urban spaces, based on the factors that underlie their behaviour, has a “great impact on the design of spaces, especially at the scale of the neighbourhood, the street and the public square” (Wall & Waterman, 2010: 121).

Moreover, it should be clarified here that there is a difference between research concerning pedestrian behaviour and walking behaviour: two separate yet complementary aspects. The latter focuses on movement rules, route choice, distance travelled, crossing behaviour and the interactions between pedestrians and traffic, primarily on streets (Turner & Penn, 2002; Papadimitriou et al., 2009). The former, which is more important to this study, concentrates on the factors affecting the culture of walking and pedestrians’ decisions to walk in the first place, in relation to aspects of the built environment.

Walking as behaviour is largely governed and guided by the socio-cultural environment; thus, the use of streets by pedestrians is primarily culturally based (Rapoport, 1990b; 1991; BaHammam, 2006). Edward T. Hall, in his book ***Beyond Culture***, clarifies this, saying that:

> “Culture is man’s medium; there is not one aspect of human life that is not touched and altered by culture. This means personality, how people express themselves [...] the way they think, how they move, [...] how their cities are planned and laid out, how transportation systems function and are organized” (Hall, 1989: 16-17).

The culture of any society has a profound effect on the use or non-use of urban spaces, and, in turn, is deeply influenced by characteristics of these spaces. The relationship between people and space is reciprocal; people design the spaces they intend to use and live in, and spaces, in turn, direct people how to use these spaces in particular ways. Urban spaces succeed or fail depending on their acceptance and intensity of use by the society. Therefore, the socio-cultural aspects are “essential to understand in order to create meaningful urban form” (Wall & Waterman, 2010: 9).

However, little is known about role of the socio-cultural aspects in shaping the street space or how the street should physically respond to certain socio-cultural aspects, particularly in the contemporary urban environment. Therefore, this section intends to review some of the related theories and concepts in order to bridge the gap between the two.

It has been already established that people's behaviour is the physical expression of their beliefs, values and norms or simply, socio-cultural attributes, which out of doors can be greatly influenced by aspects of the physical environment surrounding them (Altman & Chemers, 1984; Zeisel, 1984; Rapoport, 1991; Wall & Waterman, 2010) as well as climatic conditions (Aljawabra & Nikolopoulou, 2010). In order to have a clear understanding of pedestrians' behaviour out of doors, the interplay between culture of the society and its surrounding physical environment has to be clarified.

3.4.2 The Socio-cultural Context in Relation to the Built Environment

Generally, each discipline may view the term 'socio-cultural' through a different lens or perspective (Carmona et al., 2010). Although there are very close connections between the two notions, culture can be conceptually distinguished from society (Giddens, 2002). In the broad sense, any culture is a complex system of adopted social behaviours based on the way people live and work (Alkahtani et al., 2013). The word culture derives from the Latin word ***cultura***, which means part of people's actions (Dadfar et al., 2003), and is defined as:

> "a system of values and norms that are collectively shared between individual groups of people. These shared ideas form a foundation for the way of life of a particular group" (Adeyemi-Bello & Kincaid, 2012: 4).

Values are abstract attributes, whereas norms are definite principles, traditions and rules that people are expected to observe and follow; whether in their domestic culture or other contexts. Nevertheless, culture has a wider frame, which includes what people believe to be true of their lives (Giddens, 2002), thus, psychological factors and religious bases can largely shape cultures (BaHammam, 2006).

Culture, therefore, is accepted as a set of collective ways of viewing the world, namely, the shared values, norms, rules and beliefs that regulate how behaviours of the members of a society should be carried out. The accumulation of these behaviours is what makes the lifestyle of any society. People belonging to a specific culture and following the same lifestyle can communicate easily, whether among themselves or in relation to the built environment (Altman & Chemers, 1984; Rapoport, 1990; Al-Abdullah, 1998).

In this regard, Rapoport clarifies this, explaining that “What distinguishes one environment from another is the nature of the rules embodied or encoded in it” (Rapoport, 1977: 14), and thus culture becomes the “operating manual” for the use or non-use of public spaces so that:

> “Humans shape the landscape around them and are shaped in turn by the landscape. This reciprocal relationship is at the heart of the nature of cultures, communities and urban landscapes. A city is the product of culture, but equally, it is an important shaper and creator of culture” (Wall & Waterman, 2010: 112).

On this basis, the collective presence or withdrawal of pedestrians from the street environment, engagement in or reluctance to perform activities and the way they use the street suggest that there are much more beyond physical objects. Such attitudes carry certain meanings and messages that, in turn, are translated into behaviour; for example, to achieve privacy or to seek comfort (Altman & Chemers, 1984; Carmona et al., 2010). In this context, Rapoport (1990) emphasises that meaning is not something apart from the function of any space, but itself is the most important aspect of function, which is regarded as a manifestation or reflection of the users’ social and cultural background.

On the other hand, Giddens (2002) identifies society as the system of interrelationships which connect together the individuals who share a common culture. Any society without a place and culture is an abstraction, and hence culture is distinguished from society (Wall & Waterman, 2010). Even so, culture can be adopted, acquired and carried from one generation to another, and sometimes from one society to another. Thus, it may become universal (e.g. car dependency, walking, drive-thru, etc.) or unique to a particular society (e.g. material goods produced). Culture also covers written, unwritten and even nonverbal rules and behaviours (Rapoport, 1977, 1990) or hidden dimensions (Hall, 1966).

On the basis of this latter point, Altman and Chemers (1984) argue that the culture and built environment are linked with society by various psychological processes: among them is behavioural setting. The behavioural setting refers to what people do, and how they act and react in relation to characteristics of their physical surrounding.

Lang (1987) describes it as an environment encompassing all elements to which a person responds, and it can offer

> "a common framework for researchers and designers to both analyse the quality of environments and use findings to improve designs [...] so that environment and behaviour can be linked directly, which is essential for understanding the impact of design on [...] behaviour and for guiding design interventions" (Moore & Cosco, 2010: 40-41).

In connection with this, Westin expresses the reality of how certain socio-cultural aspects influence the environment so that:

> "People in different cultures experience the world differently not only in terms of language but also with their senses. They inhabit a different sensory world, affecting the way they relate to one another in the space, in matters ranging from their concepts of architecture to furniture arrangement" (Westin, 1970: 15).

Accordingly, the term socio-cultural is aggregate; where ***socio*** refers to the social relationships between groups within the society. The word ***culture***, as acknowledged earlier in this section, has a wide range of meanings (Carmona et al., 2010). Hall (1959) refers to culture as the total socially acquired lifestyle of a group of people, including behavioural patterns, attitudes, and repetitive ways of thinking, feeling and acting.

This signifies the unity between society and culture which forms a set of rules that govern patterns of human behaviour of which contain a wide variety of human concerns and responses (Al-Abdullah, 1998). Consequently, socio-cultural aspects can be defined "as an interlaced system of shared values and rules which form a foundation for the way of life of a particular group" (Alkahtani et al., 2013: 201).

Rapoport (1990) concludes that the meaning of the built environment differs among different groups of people, consequently leading to different judgements and choices, but he observes that this is strongly related to their socio-cultural background, which contains certain shared ideas, values and behaviours. He clarifies this in these terms:

> "social refers to more concrete variables, to the actual social structures, groups, networks, relationships, and behaviors which are manifestations of culture. Cultural, on the other hand, refers to more ideational variables, describing the "blueprint" for the social variables. [...] These, in turn, can be related to the built environment, influencing the latter or being influenced by it" (Rapoport, 1993: 10).

Indeed, it is the socio-cultural context that leads to particular ways of doing things (Rapoport, 2005), likewise; it influences walking on streets (Rapoport, 1991). In this context, Carr et al. (1992) perceive the declining rates in the use of urban spaces as a transformational process of the socio-cultural aspects, thus any transformation of outdoor lifestyle should be matched by responsive changes in the physical space.

3.4.3 Socio-cultural Aspects and Relevance to Walking and Urban Streets

The urban street in the context of social and cultural studies is the public place in any city that allows people to meet other people, see and being seen (Whyte, 2001), or simply the public theatre for human contact, where festivals, parades or even protests and strikes can take place (Sennett, 1978). The urban street is recognised "a rectangular stage set where encounters, gossip, games, fights, jealousies, courtship, and displays of pride occur" (Rossi, 1984: 86). Such human-based behaviours reflect a part of the meaning and relevance of the street in the socio-cultural context, so that the street life has become

> "a concern of anthropologists, sociologists and landscape architects among many others, and it is the result of these diverse perspectives that have led to many studies of how people use street space, and the spatial context that promotes different social potential" (Wall & Waterman, 2010: 56).

Consequently, the urban street is not only the basic urban container of pedestrian movement, but also the most fundamental spatial source for outdoor life. Streets are the urban public places where culture of the society is expressed, where outdoor users practice their daily social behaviours and activities. Cullen (1961) refers to the street environment as an outdoor room where an individual's

> "unspoken reaction to the environment [can] be expressed as 'I am in IT or above IT or below IT, I am outside IT, I am enclosed or I am exposed'". For Cullen, such "sensations are basically interlocked with human behaviour" (Cullen, 1961: 29).

However, among the questions have been posed in the literature is how the socio-cultural context plays a role in shaping urban form and streets, and what aspects have great impact. To illustrate this relation, the Arab region is briefly used below, as an example[28], even though it is discussed in more detail in Chapter Four for the Saudi context.

It has been already established that societal relations and cultural values played a pivotal role in shaping the Arab built environment in the past, and consequently defined the street layout. For example, some of the inherent socio-cultural values in Arab societies are cohesion, synergies, mutual assistance and solidarity, of which their physical reflection was translated into the compact configuration of the city, supported by environmental requirements (e.g. Al-Hathloul, 1981; Hakim, 1989; Al-Awais, 1991; Al-Said, 1992; Bianca, 2000; BaHammam, 2006; Aina et al., 2013; Sidawi, 2013; Jaber, 2013).

Another aspect is the set of socio-cultural rules, which; according to Jamel Akbar (2005), are largely derived from the legal schools of Islamic jurisprudence so as to regulate the relations among residents, between dwellers and dwellings, as well as among dwellings, whether adjacent or opposite (Akbar, 2005). Such relationships have contributed in defining – physically and spatially – the nature, character and function of the street, and hence the city form at large (Bianca, 2000; Saliba, 2015).

In this context, Sidawi (2013) emphasises that the traditional Arab city[29] was designed and built to respond effectively and dynamically to people's physical, environmental, social, physiological and religious requirements. Even more, a local street with a surrounding mass of buildings holds comprehensive social and cultural meanings (Abdelmonem, 2015).

Moreover, Carmona (2010) emphasises any urban space needs to be considered as an interaction between physical space and human activities 'socio-cultural behaviours', a relationship that is often reduced to merely the physical space. The work of Carmona (2010), Gehl and Svarre (2013), Hass-Klau (2015) and Saliba (2015) suggests that any public space should be considered far beyond just being a physical setting; rather it is the public life, including norms and customs happening within the container. In this context, Carmona et al. state:

[28] For other examples, see Tsao (2007), for Taiwan, for instance.

[29] Some well-known researchers call it "historical Islamic architecture".

> "The public realm has 'physical' (i.e. space) and 'social' (i.e. activity) dimensions. [...] the physical public realm means the series of spaces and settings – which may be publicly or privately owned – that support or facilitate public life and social interaction. The activities and events occurring there can be termed the sociocultural public realm" (Carmona et al., 2010: 135).

Similarly, when Sharon Zukin (2000) asked questions in ***The Cultures of Cities*** such as: 'Whose culture? Whose city?', she was concerned with a fundamental issue: who really occupies the public space of cities? Indeed, there are various socio-cultural aspects concerning urban streets which cannot be covered in single study, owing to the diversity of concerns of each culture. In support of this perspective, Rapoport asserts that "Cultural variables are primary for any activity, including walking and others, occurring in streets. It is culture that structures behaviour and helps explain the use or non-use of streets" (Rapoport, 1991: 83). This, explicitly, means that walking on streets is primarily a context-sensitive issue and differs from one culture to another.

It has been recommended when dealing with socio-cultural aspects related to outdoor spaces that it is useful for landscape architects to narrow the scope of these aspects "to specifically refer to community with propinquity – a group of people with social cohesion, who share a geographical location" (Wall & Waterman, 2010: 113). Consequently, among the questions posed in EB studies is how to measure those variables and qualities of urban spaces relevant to design (Moore & Cosco, 2010) that are socio-culturally responsive. Because the terms society and culture cover almost all aspects of human activities and behaviours, a defined scope of study is necessary for this thesis. Among the most explanatory theories that interconnect pedestrians' behaviour (as manifestation of the socio-cultural aspects) and the physical environment is the theory of spatial behaviour.

In this context, Sanders (1993) verifies that the spatial environment, including the physical components, "can reinforce or inhibit human behavioural responses and expectations", and such "responses can be explicitly observed and defined" (Sanders, 1993: 47). Similarly, changing streets change behaviour, meaning that a street design is guiding user behaviour through physical and environmental cues (NACTO, 2013). Gehl places further emphasis on this relation by clearly stating:

> "No matter how much work is devoted to climate, lighting, furniture and the many other factors important to city quality at eye level, the effort is almost in vain unless spatial quality, proportions and dimensions are subject to careful scrutiny" (Gehl, 2010: 162).

3.4.4 Theory of Spatial Behaviour

Like the diversity of verbal languages of world communities, the human body also has its own nonverbal communication language that, likewise, is not standardised or universal. Hence, the spatial behaviour itself is a kind of language or style of communication that depends on who is interacting with whom – i.e. interpersonal relations or people with their physical surrounding. It can be said, therefore, that the spatial behaviour is a variable that differs from one culture to another, from one pedestrian to another, and even the same pedestrian may behave differently in different cultures and environments (Rapoport, 1990).

A pioneering example of the importance of studying the spatial behaviour out of doors is the observation of William H. Whyte (1980, and reprinted in 2001) of several plazas and small parks in New York City. Whyte was primarily interested in understanding the interplay between behaviour of outdoor users and outdoor physical spaces. His ultimate aim was to explore why some urban spaces respond or 'fit' well to needs of these users while others fail so as to identify the basic elements of successful urban spaces. His first-hand mechanisms were based on interviewing the pedestrians, watching what they do and even employing a time-lapse camera overlooking the spaces under investigation, to record daily behavioural patterns.

Beside such useful methodologies and data collection techniques documented from Whyte's work, the importance of his study to this section is that much of what he observed clearly indicates that pedestrians often search for more than mere physiological comfort or visual quality. In fact, Whyte even pinpoints the fact that pedestrians will sometimes undergo a certain degree of physical discomfort to fulfil their basic psychological needs. This explicitly reveals the significance of understanding pedestrians' behaviour – including the influential socio-cultural aspects – in their actual settings.

Based on Whyte's discussion, it becomes clear that what is most difficult to change is what is most important to the intended users for whom the urban space is designed

(Whyte, 2009). Thus, for the street space to function truly well, its design must be central to serve the requirements of the local context. Similarly, Kevin Lynch (1984), in his theory of good city form, conceives the city as a human artefact designed to serve human needs. He proposes a set of performance tools as a means to analysing the linkage between spatial form and social processes. Among such tools related to outdoor spaces are ***access***, ***control*** and ***fit***, which are normally interrelated.

Lynch argues that a good physical environment provides convenient ***access*** to a moderate variety of people and settings, and this includes a better quality of life and space. ***Control*** refers to the connection between behaviour and place, so that outdoor users need to manage personal interactions by asserting rights over territory. Canter states that "one of the major roles of human spatial behaviour is to control the quantities and quality of interaction in which a person will take part" (Canter, 1974: 123). ***Fit*** refers to the relationship between place and behaviour – a place works well when it is fitted to what its users want to do and feel comfortable (physically, spatially, thermally, psychologically and so on).

Different behaviours' 'activities' require different physical qualities and spatial arrangements. This means it is very important for urban designers and landscape architects to be aware of how the intended activity will be actually performed by the expected users in the designed space, as well as to fully understand the influential socio-cultural aspects associated with that activity.

For example, BaHammam (1995) observed, in his PhD study of public gardens in Riyadh, the location of benches is mostly placed along the footpaths and that these are rarely used. Although the author believes the lack of use of those seats can be strongly associated with the national costume for both genders, BaHammam attributes this phenomenon to the lack of awareness by designers[30] of the users' spatial behaviour that is governed by socio-cultural aspects in that

[30] The author believes this is not the main reason behind the occurrence of this phenomenon in Saudi Arabia. In addition to BaHammam's interpretation/ observation, the author notes that dust on a rough surface such that of the concrete benches most often contributes to leaving coloured patches or dirty marks on the white thobe for men and black abayah for women.

"sitting along the footpaths, the person exposes him/herself to the passers-by, which means that the sitting person is losing a very important aspect of the Saudi culture which is the desire for privacy" (BaHammam, 1995: 49).

Accordingly, the spatial behaviour is the reciprocal relationship that is established between the spatial dimension of one's environment and the people who use it (e.g. Canter, 1974; Hall, 1966; Sanders, 1993; Sommer & Sommer, 2002; Gehl, 2010; Benessere, 2015). In other words, it is the spatial interaction existing among people and between people and their physical environment (Wall & Waterman, 2010). This is a theory that has been mainly studied in *Anthropology*, which, through the study of human behaviour and physical setting, tries to discover the socio-cultural meaning with respect to different ways of using spaces, or simply territorial behaviour and distance regulation (Figure 3.28).

Figure 3.28 Like birds, pedestrians by nature seek to regulate their outdoor spatial behaviour by maintaining distances with others (Source: Gehl, 2010: 48)

In the case of this study, pedestrians' spatial behaviour in the street space becomes more understandable if we consider it as a style of communication by which pedestrians attempt to express and reflect certain values/attitudes; acceptance or rejection of this space by their presence or withdrawal. In connection with this, Rapoport states:

"People typically act in accordance with their reading of environmental cues (revealed meanings). This follows from the observation that the same people act quite differently in different settings. This suggests that these settings somehow communicate expected behaviour if the cues can be understood. It follows that the 'language' used in these environmental cues must be understood; the code needs to be read. If the design of the environment is seen partly as a process of encoding of information, then the users can be seen as decoding it. If the code is not shared or understood, the environment does not communicate" (Rapoport, 1990: 57).

Thus, it can be argued that the rationale behind the composition of the street space depends on our understanding of the forces that put demands on particular components in this daily landscape. In case of the behavioural aspects in street design, rationality is dependent upon our understanding of the factors or values that underlie the behaviour which may encourage or discourage walking.

Gehl (2010), in relation to urban spaces, culture and behaviour, demonstrates that public spaces should be designed for the scale, senses and dimensions of the human on foot – three essential components cannot be fulfilled with current practices of street design prioritising cars over pedestrians. He emphasises the importance of two criteria located under these components: 'distance' senses and 'close' senses. Gehl, in this respect, explicitly draws attention to seriously considering the works of Robert Sommer (1969), Edward T. Hall in his books ***The Silent Language*** (1959) and ***The Hidden Dimension*** (1966) and Irwin Altman (1975).

Indeed, all these are among the key researchers who stress the important aspects of the physical environment and its impact on human spatial behaviour. They demonstrate not only how people actively shape their physical surrounding, but also how they react to the existing environment. Hall, in his books, focuses on how different cultures use spaces differently, owing to the influential role of certain socio-cultural considerations. Therefore, Hall illustrates people's behaviour in the space, 'spatial behaviour' among themselves and in relation to their physical environment, through the ***Proxemics Theory***. Nevertheless, it has been already observed that:

> "in public places relatively little study has been carried out of the way in which people relate themselves to [...] their physical surroundings [...] One reason [...] is the observation that much of human spatial behaviour is more readily explained in terms of the relationships people take up in respect to other people [i.e.] locate themselves in a desired position with respect to the activities of others rather than simply their physical surroundings. However, it must not be forgotten that there clearly are cases in which people do deal with physical entities seemingly independently of their social implications" (Canter, 1974: 113).

In addition, Gehl (2010) points out that the distance factor, among outdoor users, needs to be taken into account as a powerful communication language, affecting the design of, and being affected by, the characteristics of the physical space. It hence differs from one culture to another, leading to use or non-use of urban spaces.

Drawing on this approach, pedestrians' spatial behaviour, their presence or withdrawal from, walking inside or outside the urban street, can be an important indicator of the degree of the impact of such nonverbal, hidden or innate language. This language can be regarded as the

> "medium of communication that we use to indicate our feelings of, or attitudes towards, the type of activity in which we intend to engage [so that] the use of space may be considered both as determined by the people and a determiner of human behaviour" (Canter, 1974: 121).

More clearly, Gehl asserts that "working with the human scale means providing good city spaces for pedestrians that take into account the possibilities and limitations dictated by the human body" (Gehl, 2010: 33). He further places much emphasis on

> "cities to achieve social sustainability, attempts must reach far beyond physical structures. If cities are to function efforts must focus on all aspects from the physical environment and social situations to the less obvious cultural aspects that have great significance on how we perceive individual quarters and entire city societies" (Gehl, 2010: 109).

On this basis, besides economic, political and environmental stimuli, pedestrians' behaviour out of doors is a physical reaction or manifestation of internal socio-cultural considerations, whereas the physical environment is seen as a major player that affects their behaviour (Altman & Chemers, 1984; Moore et al., 1985; Lang, 1987; Moore et al., 1997; Wall & Waterman, 2010).

Similarly, Al-Abdullah (1998) confirms that outdoor users' behaviour in Saudi Arabia is intimately linked with qualities and characteristics of their immediate environments, both human and physical. Accordingly, it can be said that the design of urban streets should fully understand the interrelation between pedestrians (including the most relevant socio-cultural aspects) and characteristics of the physical environment. However, what are the mechanisms involved in the translation of cultural aspects into physical form?

Rapoport argues that "It is not possible to design for culture but it may be possible to show that particular parts of the environment are supportive for specific components of culture". He further emphasises that "one does not translate culture into built form. Rather, some aspects of culture (lifestyle, behaviours, social structures, status, power relationships, meaning and so on) are translated into some aspects of built form:

some components of culture are related to some components of environment" (cited in Tsao, 2007: 27-28). Thus, the design of the street space (physical and spatial characteristics) may support or hinder walking (Rapoport, 1991).

Nevertheless, outdoor users' behavioural responses to the physical environment comprise of nonverbal social rules and cultural conventions, although these are visible and measurable behaviours (Moore et al., 1985). For example, "personal space, territoriality, privacy regulation, and boundary controls. Each is reflected in the organizational features of the built environment and its associated artifacts". Although these four components are considered the determinants of the spatial behaviour, they "overlap; they have fuzzy edges" (Sanders, 1993: 47).

Accordingly, given that walking is a human behaviour as much as physical activity, and is influenced by behavioural stimuli that differ from culture to culture and from city to city (Wall & Waterman, 2010), it is more appropriate to review the spatial behaviour in relation to specific socio-cultural studies, within which emerges the concept of ***proximity***. This is based on the fact that an important influence on spatial behaviour is the impact of people's interaction with the available characteristics in any given space, but most important is the impact of interpersonal interactions in that particular place.

Therefore, it can be argued that basis of much daily human behaviour is subtle and is not customarily linked to the everyday physical surroundings, and hence proximity can be regarded as a significant quality ensures success or failure of urban spaces (Whyte, 2001; 2009; Gehl, 2010). In support of this postulate, it has been long recognised that:

> "we are surprisingly sensitive to distance in our everyday behavior [...] Knowledge of distance is essential for planning any strategy of spatial behavior [that] is not as simple as it might appear. We must store many bits of distance […] data to operate efficiently in a spatial environment" (Downs & Stea, 1973: 16-17).

Indeed, ***proxemics*** is among the spatial behaviour theories associated with interpersonal spatial relationships and the influential role of an individual's socio-cultural aspects in relation to the physical environment. Therefore, it is reviewed in the following paragraphs, due to its strong relevance to the core of the study.

3.4.5 Proxemics Theory

According to Tolley (2015), the study of proxemics, sometimes referred to as personal space and interpersonal distances, was founded by Edward Hall (1959), although Robert Sommer (1969) and Irwin Altman (1975) conducted seminal work in this area. In years later, their findings have exponentially enriched studies of spatial behaviour and “stimulated a considerable amount of research and writing on the description and comparison of differences in the structuring and use of space” (Aiello & Thompson, 1980: 107). Moreover, a recent study postulates that research in this area and its “relationship to the built environment will probably increase in the coming decades” (Namazian & Mehdipour, 2013: 109).

Although nearness in physical distance, known as interpersonal distances or simply proximity, is a relative aspect that differs from culture to another, it is a very important quality and may become the most significant of all aspects that regulate specific societies in public spaces (Bahammam, 2006). Basically, it is the dynamic amount of space that people feel necessary or comfortable to maintain between each other, which relates directly to innate qualities of human spatial behaviour. For instance, observing two Arab close friends, one can notice they are relatively close and even may hold hands, while the Americans prefer to maintain a distance of at least one arm’s length (Gehl, 2010). Likewise, when an American meets an Asian person, the conflict becomes apparent and discomfort arises where the Asian tries to move closer whilst the American takes a step backward in order to maintain accustomed distance.

Hall (1966) attributes the reason for such behavioural attitudes to the influence of cultures where he groups them into ***“contact”*** and ***“noncontact”***. He classifies Mediterranean, Arabic, Asian and Latin American societies in the first group and describes them as highly sensory cultures where people accept living in close physical contact and allowing close interaction distances. In contrast, he places societies of north Europe and America in the second group and describes them as somewhat more reserved; thus they are more likely to demand larger distances, especially in public settings and with strangers (Aiello & Thompson, 1980).

Additionally, Robert Gifford and others stress that interaction among males requires the largest interpersonal distances, attributing the reason to the fact that "Males are often more territorial than females" (Gifford et al., 2011: 444). He further finds interpersonal distances among women are closer than among males, followed by male-female interactions (Gifford, 2007). The latter point was also observed by Steven Madden (1999) in a study examining gender effects on proximity between 506 strangers, males and females, in a public setting. Results showed that females are more often at a closer distance to males than in female-female situations.

Madden states that: "Statistically significant results from the study were not as predicted", and hence "distance by gender seems to be encouraged by other variables" (Madden, 1999: 41). Indeed, Madden's study illuminates other research questions as to what other factors play a role in proxemics beside gender; does the environment contribute to the distance between two people when they are interacting? For this, Gifford et al. (2011) emphasise that the physical and spatial arrangements of outdoor environments, in particular, should carefully respond to such nonverbal aspects.

However, the objective analysis entails posing a question if such observations by Hall, Gifford and Madden fit with other cultures, particularly when male-female interaction represents a sensitive issue, such as in the Middle Eastern societies. This issue has become of a central importance to this thesis after conducting the fieldwork.

To give an example, although it contradicts with the above researchers as will be discussed in detail with illustration under 4.3, in Islamic societies, mainly in the case of the Arab countries, when a certain situation involves the interaction/presence of two opposite genders (non-relatives), the distance between them becomes greater than in other societies, owing to the Islamic teachings. Although the distance is unspecified, Islamic teachings strictly require the public to maintain a boundary – physical and visual[31] – with the opposite gender, to prevent any formal promiscuity

[31] A woman in Islam is expected to seek protection for her own body from being seen or touched by anybody except very close relatives. At the same time, men are expected to lower their gaze and not stare at women.

from either side. Such a legislation or rule makes the interpersonal distance a very important hidden dimension which regulates the relationship between individuals and can directly affect the use of or withdrawal from public urban spaces (e.g. Aiello & Thompson, 1980; Bahammam, 1995; Al-Abdullah, 1998).

In support of the latter point: "Wherever people communicate directly with others, we can see how they constantly use space and distance. We move closer, or lean forward, or withdraw discreetly" (Gehl, 2010: 48). Indeed, Gehl acknowledges that the existence of such nonverbal "communication ground rules is important in order for people to move securely and comfortably among strangers in public space" (Gehl, 2010: 49). Therefore, once these rules are invaded or underestimated, outdoor users feel discomfort; thus they may feel compelled to move into alternative places.

Clearly, certain factors (e.g. gender, age, religious rules) have been found to play a role in regulating proximity, and hence degree of proximity can expand or shrink from one culture to another. To a very large extent, proximity in the public realm is a function of the relationship among the people involved in a certain space as well as culture of the society to which those people are accustomed. It only becomes important when people interact with others at a specific time and place in a range of situations, i.e., day or night; in a public or private space; watching parades or picnicking (Pease & Pease, 2004; Tolley, 2015).

Accordingly, ***Theory of Proxemics*** can be interpreted as a behavioural response in a physical action influenced by certain socio-cultural considerations, and hence it is dubbed as a hidden dimension or nonverbal aspect. Canter describes it as "the hidden, innate forces which determine what people do" (Canter, 1974: 123). Hall demonstrates that cultural expectations about proximity vary widely and it is unconsciously internalised in all people, which – if not carefully considered – can lead to serious failures of communication among people, as well as between people and their physical surroundings.

In this respect, the concept of proximity is "undoubtedly related to the use of space in a more public or private way" (Scheerlinck, 2010: 46). Proximity is "the study of how man unconsciously structures microspace – the distance between men in the conduct of daily transactions, the organisation of space in his houses and buildings, and ultimately, the layout of his towns” (Hall, 1963: 1003). As such, Hall sees the framework of proxemics as “the interrelated observations and theories of man’s use of space as a specialised elaboration of culture” (Hall, 1966: 1); and “the study of man’s transactions as he perceives and uses intimate, personal, social and public space in various settings while following out-of-awareness dictates of cultural paradigms” (Hall, 1974: 2).

To exemplify how the concept of proximity can influence the use of urban public spaces, although the primary focus was on sedentary pedestrians, William Whyte explains: “When there are few people around, the comfortable distance between strangers is fairly wide. If you are one of the few people sitting, and a stranger comes and sits on your bench instead of an empty one, there can be a strong feeling of intrusion” (Whyte, 2009: 116-117).

Furthermore, the framework of proxemics is often discussed in relation to the built environment in terms of personal space, territoriality, privacy regulation and crowding (e.g. Altman, 1975; Zeisel, 1984; Madanipour, 2003; Carmona et al., 2010; Gehl, 2010; Namazian & Mehdipour, 2013), although these concepts overlap and have a very thin line which separates them (Sanders, 1993). This is because the term is, to some extent, “misleading, since in fact what we are considering is interpersonal space” (Tolley, 2015). For example, Carmona et al. use “privacy” to refer to personal space when they acknowledge that: “In many eastern cultures, concern for privacy has often been a major structuring element of urban areas” (Carmona et al., 2010: 217). Accordingly, the study uses the term ***personal space***, which forms the underlying basis of all these concepts, and based on the fact that the street space is a dynamic public domain compared to other urban spaces commonly intended for static recreational functions.

3.4.5.1 Personal Space

Personal space is the preferred interpersonal distance that an individual maintains within a given setting. It is defined as the “area with an invisible boundary surrounding the person’s body into which intruders may not come” (Sommer, 1969: 26). For Hall (1966), it is the invisible portable “bubble” or “air space” which all people carry around their bodies, and defines how close they will approach to other people and how close they will allow others to approach them. It is a continuous variable that affects social interactions and space use, and varies in accordance with a range of situations and circumstances (Pease & Pease, 2004; Tolley, 2015).

Similarly, Whyte reaffirms that in public urban spaces, namely streets and squares, pedestrians are subject to criteria of social interaction, thus: “Social distance between people is a subtle dimension, ever changing” (Whyte, 2009: 121). Likewise, Gehl argues that walking requires a reasonable amount of space, so that: “Wherever physically possible the individual seeks to maintain the narrow but vital distance that keeps the situation secure and comfortable” (Gehl, 2010: 49).

Moreover, according to Pease and Pease (2004), the size of this portable “bubble” is dependent on the density of the population in the place where people grew up, and hence it is culturally determined. However, other factors that influence the personal space have been found in the literature, some of which can include gender, age, religious rules, personal traits, behavioural attributes, situational effects, competition and cooperation, social status, as well as expectations and social perception.

Hall (1966), in his book ***The Hidden Dimension***, categorises personal space into four groups, each of which is subdivided into two sub-categories based on distance: “close” and “far”, as presented below and illustrated in Figure 3.29.

(1) Intimate Distance ***(15 – 46cm)*** is the distance for exchanging close emotional impressions (e.g. whispering, holding hands) or in situations requiring a certain body contact (e.g. wrestling match); a zone where the presence of others is not welcomed unless by special invitation. Innately, people strive to protect this zone, so that everybody else is kept, quite literally, at least at arm’s length, because “man is a “do-not-touch” individual” (Gehl, 2010: 49).

(2) Personal Distance ***(46cm – 1.22m)*** is the distance generally reserved for intimate partners and how close people stand from others at social functions and friendly gatherings. Therefore, two sub-distances in this zone: (a) the close phase (46-75cm) is reserved for couples or very close friends; (b) the far phase (75-122cm) is used by acquaintances or friends and defined by arms’ length.

(3) Social Distance *(1.22 – 3.7m)* is the "boundary line between the far phase of personal distance and the close phase of social distance marks […] the 'limit of domination'. Intimate visual detail in the face is not perceived, and nobody touches or expects to touch another person" (Hall, 1966: 121). It is the distance where people feel comfortable conducting routine social interactions with acquaintances as well as strangers.

(4) Public Distance *(3.7 – 7.6m+)* is the distance beyond which people will perceive interactions as impersonal and relatively anonymous. Thus, several important sensory shifts occur in this zone. This is the comfortable distance at which people choose to stand for watching public addresses and parades, for example.

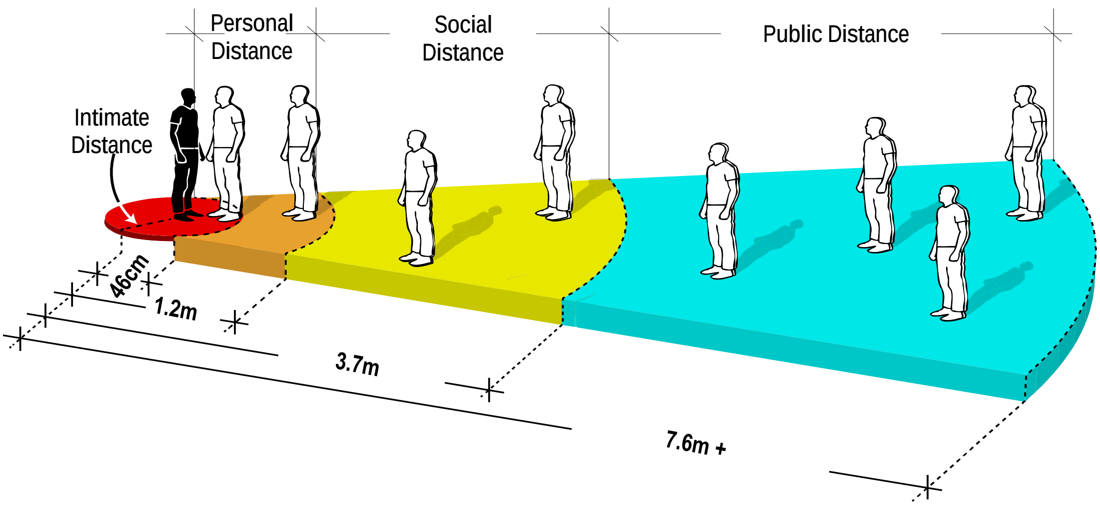


Figure 3.29 Zones of personal distances (Source: the author)

It is significant to note here that all distances under each category reviewed above were identified around middle-class people living in Western cultures. Therefore, other societies, as is the case in this thesis, may experience larger or smaller personal space than those discussed above (Pease & Pease, 2004).

3.4.5.2 Personal space, Walking and Urban Streets

It is very rare or even difficult to find studies attempted to measure, by empirical evidence, Hall's categorisation of personal space among pedestrians or walking on streets. But, numerous studies have focused on seating arrangements and distances in indoor settings (e.g. doctors' waiting rooms, libraries, classrooms), while some urbanists (e.g. Whyte; Gehl) turned their attention to the study of human spatial behaviour in public urban spaces, mainly by observing static pedestrians (i.e. seated). Thus, only one empirical study found during this literature review, examined the personal distance within the context of walking on streets, which was undertaken in South Africa.

Nathan Destro, a Digital Arts postgrad in University of the Witwatersrand, created an invention entitled “Personal Space Protector” (Figure 3.30), which he designed in a Masters’ workshop held in Johannesburg in 2009. He conducted a street test by carrying a portable bubble, made of flexible material, with a radius of 50cm, representing the close phase of the personal distance as identified by Hall (1966). The invention serves two primary functions: (a) to practically test if the personal distance is psychologically and physically comfortable among pedestrians while walking, and (b) to evaluate if pavements are spatially-responsive to contain this human need. He concludes the personal distance may be suitable for static pedestrians (seated or standing), but for dynamic pedestrians, he suggests more investigation is required.

Figure 3.30 Testing the personal distance while walking among pedestrians in urban streets, Johannesburg, South Africa (Source: Destro, 2009)

3.4.5.3 Methods of Measuring Personal Space

The major methods of measuring personal space are described below, each of which has its advantages and disadvantages and may include sub-techniques. It is commonly accepted that due to the sensitive nature of measuring personal space there is no ideal method (Sturt, 2010). The following review is based on the work of Aiello and Thompson (1980); Sturt (2010); Fisher (2014) and Tolley (2015).

(a) Naturalistic/Field Observation: is considered a better measure of personal space, as it is carried out in actual settings where natural everyday behaviours take place, thus more reliable and realistic. It is typically measured by eye, by counting paving tiles between two pedestrians or by proportioning the distance to dimensions of a known fixed feature. Although this method may lack accuracy as well as raising the ethical implications associated with observing people without their consent, it can be divided into two techniques:

- *Structured interactive techniques:* typically, by observation in a field setting that has been adapted by the experimenter, such as in modified classrooms;
- *Unstructured interactive techniques:* mainly by observing the personal distances among actual users in their natural settings.

(b) Simulation/Laboratory Experiments: in which variables are controlled, thus measurements can be taken. Techniques, under this method, allow researchers to control many potentially confounding variables, but the artificial environment may not be useful for generalisation to everyday behaviour:

- *Quasi-projective techniques:* typically conducted in a laboratory setting where participants approach target persons to a point where they begin to feel uncomfortable or are asked to respond to actual distances from others;
- *Projective techniques:* in these studies, figures or symbols as visual surrogates for humans are presented to participants, who are in turn asked to arrange them or make judgments about the distance between them.

(c) Questionnaires: in which participants have to rate, on a scale, the preferable distance from strangers at which they feel comfortable. An example is the *Comfortable Interpersonal Distance Scale*; developed by Duke and Nowicki (1972 cited in Fisher, 2014; 371-372). This technique allows a precise measurement of the personal space as required and evaluated by the actual users in different situations, although participants could overestimate or be not clearly imagining the distance.

3.5 Summary

Through this extensive review chapter, the second sub-question of the study was answered. The urban street is the pedestrians' daily landscape with a multifaceted nature and not a fixed entity in the city. Pedestrians always appreciate noticeable differences, complexity and quality of surrounding details, due to their low speed of movement and close distance to objects. Therefore, streets need to change and evolve as necessary to satisfy the pedestrians' needs, which evolve over time as well. Thus, the concept of redistributing the street space emerged as a rational and effective design solution to restore the pedestrians into this space.

Accordingly, rightsizing streets serves three major functions: (1) to accommodate the necessary climatic-responsive design interventions so as to modify the microclimate and thus provide better thermal conditions for pedestrians; (2) to incorporate streetscape elements to facilitate the pedestrians' movement, enhance the walking experience both functionally and visually (aesthetically) and eventually to encourage extending the length of use of the space, and (3) to satisfy the pedestrians' spatial behaviour, which is being largely influenced by certain socio-cultural aspects.

Restoring the pedestrians into the street space has been possible to attain in many parts of the world, mainly by concentration on the characteristics of this space; physically, spatially and thermally, at the eye level, as experienced by the actual pedestrian. For this, several environmental quality criteria/ requirements have been identified as necessary and recommended for encouraging the pedestrians to enjoy the walking experience and stay longer in the street space. Specifically, more attention of street design needs to be given to the design details, safety measures, increase in urban trees, width of pavements and adopting climatically responsive urban design strategies. This requires assessing pedestrians' thermal comfort, which can be efficiently measured by application of the Physiological Equivalent Temperature index 'PET' through use of the ***RayMan*** Software.

Moreover, the pedestrians' spatial behaviour can be governed and guided by certain socio-cultural attributes, among which are those explained by the personal space theory, which has been found to represent a hidden dimension that can significantly affect how urban spaces are used. Nevertheless, there is a scarcity of studies focused on this innate human quality during walking and how it relates to the characteristics of the street space or how the street should be responsively designed to fulfil this need.

Furthermore, apart from the fact that what has been achieved in this review chapter contributes to moving the research to the next stage, it would be more helpful to include further reviews of the available sources on a specific context. Therefore, the next chapter will present some factual materials pertinent to the research issue in Saudi Arabia, with particular focus on the case of Dammam city.

Chapter Four: Existing Conditions of the Saudi Context with Specific Reference to the Case of Dammam

"To change and to change for the better are two different things" (German proverb)

4.1 Introduction

The previous chapter reviewed the theories and issues most pertinent to the aims of reclaiming the urban streets for walking. This was based on combining: (a) an understanding of the physical and spatial characteristics of street design that can effectively contribute to improving the pedestrians' thermal comfort in hot-humid urban environments, and (b) an exploration of the pedestrians' behaviour in the socio-cultural context. These reviews were coupled with illustrative examples of the principles and themes that form the basis of this thesis.

To follow this, the present chapter provides a more in-depth emphasis on some factual material from the Saudi context with three primary goals: **(1)** to understand the roots of the research problem through a historical review of the forces behind transformation of the traditional street patterns into the contemporary layout; **(2)** to analyse the physical and spatial characteristics of the existing street space in the case of Dammam city; and **(3)** to gain rich insights into the most sensitive socio-cultural aspects related to the use of outdoor public spaces for the Saudi context. Therefore, this chapter responds to the third objective of the research and is divided into three main sections responding to the three goals above.

4.2 PART ONE: The Built Environment in the Saudi Context

4.2.1 Background information on Saudi Arabia

(1) Brief historical, political and economic overview

Saudi Arabia was unified by the founder, King Abdul-Aziz Al Saud on the 23rd September 1932. At the time of the unification process, most areas consisted of three major types of independent communities; namely, rural, urban and nomadic. While the first group was mainly made up of farmers, concentrated around oases, the urban inhabitants were either living in walled settlements or in fishing hamlets. The third group consisted of desert dwellers of scattered tribes living in tents and concentrated around water resources.

Today, the Kingdom has been transformed into a modern state and has gained its global importance due to two factors: (a) being the country that houses the two holy mosques in the cities of Makkah and Medina, both of which are considered of special significance in Islam and for Muslims, and (b) being one of the largest oil producers in the world, that holds over a quarter of the global oil reserves. The presence of oil has provided the country with unmatched economic prosperity, extensive urban growth and rapid large-scale development in a very short time, although this process has often been accompanied by several consequences. Some of these may have been generated under certain unavoidable circumstances, due to difficult conditions and/or limited resources, but their implications may appear after decades.

(2) Geographical location, area and borders

The Kingdom is situated between Africa and mainland Asia, and occupies about 80% or 4/5th the land of the Arabian Peninsula, with long frontiers on the Red Sea and the Arabian Gulf. It is the second-largest country in the Middle East, and ranked the 13th largest country in the world (CIA World Factbook, 2014) with a total land area about 2,250,000 Km^2. This large tract of land represents nine times the land area of the UK, as an example for comparison.

The country is bordered by Kuwait, Qatar, UAE and the Arabian Gulf to the east, and Bahrain represents the offshore boundaries. Oman extends from the southeast to the south, with Yemen, while Iraq and Jordan lie to the north. On the western boundary is the Red Sea, while Egypt, Sudan and Eritrea are located on the other side of the Red Sea (Figure 4.1). Each part of the Kingdom has been largely affected by the culture, building style and construction materials of the bordering countries. For example, the eastern region is noticeably affected by the norms, dialects, social customs and traditions of the other Gulf states, due to physical proximity and fairly close similarity in topography, climate and social relationships.

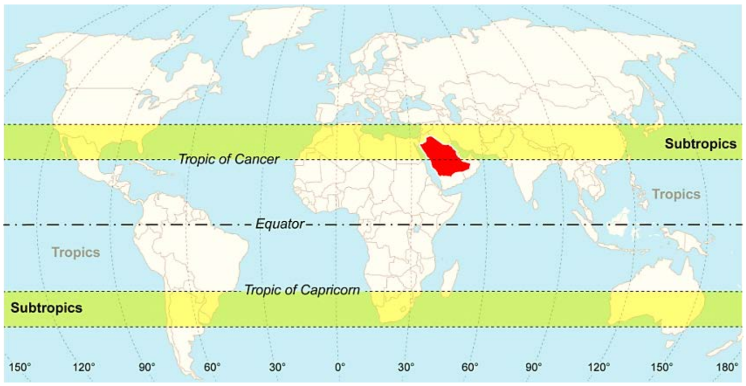


Figure 4.1 Location of Saudi Arabia in the world

(3) Population

In 1937, the population was estimated under 5 million (Al-Shuaiby, 1976). Today, the country is approaching 31 million inhabitants with a population density about 15.3 people/km^2 and population growth rate at 2.55%, by 2014 (CDSI, 2015). Due to certain socio-economic factors (industrial, commercial and recreational activities), combined with overall scarcity of freshwater and agricultural resources, nearly 88.5% of the population is concentrated in urban areas (Zatari et al., 2005; Abou-Korin, 2011). Over 50% of this segment lives in coastal cities (Zatari et al., 2011).

(4) Landforms and landscapes

The Kingdom encompasses various topographic features and landscapes, but is generally composed of six main physiographic elements ranging through sandy and rocky deserts, valleys, mountains, lava-areas, meadows to 'Sabkhas[32]'. Geologically, the whole country lies above a vast platform that slopes down gradually from the mountains in the west until it reaches a vast, flat and low-lying plain parallel to the shore-line in the Eastern Province (Zatari et al., 2011).

Environmentally, one of the prominent features that characterises Saudi Arabia is its location in an area that has one of the harshest, most limiting environments on the face of the earth (Kelly & Schnadelbach, 1976). It is one of the most arid and thirsty

[32] Sabkhas are salt marshes formed due to the evaporation process of brackish water leaving the salt deposited on the surface. This process occurs by deposition of silt, clay, and muddy sand in shallow water occurring in depressions where there are water seepages. Water is usually found within a few feet under surface, while a mixture of salt and sand forms a flat and dry crust a few inches deep on surface (Al-Shuaiby, 1976).

large countries that lacks rivers and natural lakes; notwithstanding this, it consists of a variety of ecosystems and habitats for both flora and fauna. About 76% of its total area consists of non-arable lands of which sandy deserts form almost 70% (Zatari et al., 2011; Bin Marshad, 2014).

4.2.2 Influential forces behind formation of the traditional urban form in Saudi Arabia: the role of Islam

It should be pointed out here that the Arab region encompasses a vast territory that stretches from the east shores of the KSA to the west coast of Mauritania. The people of the countries located in this region share three main aspects of life: (a) they speak the same language (Arabic), (b) they are affected by a hot-arid climate and (c) they embrace the same religion (Islam), except in Lebanon, where Christianity is the dominant religion. The reason behind this clarification is to establish a basis for the reader to understand that the traditional urban pattern that prevailed in the Kingdom was influenced by factors (b) and (c). The climatic conditions and the Islamic culture have played a leading role in shaping the Saudi city. Several scholars have already focused their studies on this relationship (e.g. Al-Hathloul, 1981; Fadan, 1983; Hakim, 1989; Al-Said, 1992; Akbar, 2005; BaHammam, 2006; Al-Naim, 2008a; Jaber, 2013).

It is also appropriate in this thesis to briefly shed some light on the essential underlying factors that have shaped the traditional built environment in Saudi Arabia before its transformation into the contemporary form. Reviewing history of the context and the phenomenon under study can be a very helpful source to understand the root of the research problem (Torre, 1989). Abu-Lughod, in this context says:

> “The reason why we are interested in traditional forms of building, dwellings, and settlements is that we believe that such achievements met human needs in a more sensitive way than contemporary and/or alien methods do. It is this belief that sends us back to the past, and that sends us to the local and the specific” (Abu-Lughod, cited in Bianca, 2000: 185).

Focusing on local conditions in city design can be the key element to reach the halfway point to unpacking the complex ecology of the phenomenon under study. Indeed, the traditional Arab built environment was an intricate communication system of social, economic, political and cultural interactions that produced the form and gave dynamism to the city, through time (Hakim, 1989; Jaber, 2013). Therefore, the following paragraphs are not about style of the traditional city, nor about buildings in isolation. Rather, they are about the influential role of the socio-cultural values, which in the Arab world are largely derived from the Islamic religion, in forming the building codes and the resulting built environment.

Kennedy (1985) argues that the early traditional Arab city, with its compact form and winding street pattern, was not deliberately planned out of any conscious aesthetics or cultural preferences, nor was the resultant built environment related to the role of Islam. Kennedy also points out that some cities were planned by the rulers, and adopted orthogonal plans. He further maintains that there were no legal restrictions, so that dwellers were free to expand their private properties into the street space without permission from anyone or compliance with particular building codes.

Nevertheless, Brunschvig (cited in Jaber, 2013: 6) demonstrated that there was clear evidence of the influence of Islam on developing the traditional Arab city. The Islamic law had made a strict distinction between properties of the public and private domains. The public spaces were planned under certain restrictions on obstructions, as well as regulations on street width and overhead projections, which were not applicable to the private ones (Hakim, 1989; Akbar, 2005). Similarly, Al-Hathloul (1981) asserts that the traditional Arab city always evolved organically following a set of conventional principles mostly governed by the Islamic guidelines that are considered binding on any member of the society, as well as being influenced by local climatic conditions (Alznafer, 2014).

On this basis, the traditional built environment, despite the simplicity of its appearance, was, in its essence, a very complex form, which complied with strict standards. There were legislations for almost all possible cases, from the upper projection over the street, the window opening and down to street width (Al-Hathloul, 1981; Hakim, 1989; Al-Said, 1992; Sidawi, 2013). Accordingly, Islam is not a mere relationship of a person with Allah (God), rather, it is a way of life that regulates an individual’s life, governs interpersonal relations and behaviours as well as people’s interactions with their surrounding environments, and which, thus, has eventually influenced the final form of the built environment.

To exemplify this influence on the built environment, which supports the belief that the socio-cultural context is largely guided by the Islamic culture, the design principles of privacy and enclosure are highlighted. The traditional city was composed of several housing clusters, which, in turn, were composed of courtyard houses that were often surrounding cul-de-sacs. Such an ‘enclosed’ and ‘introverted’ urban setting “perfectly served the requirements of the Islamic social order centred on the holiness of family life but [was] equally optimal for the climate” (Jaber, 2013: 12). This enclosure, in addition to its efficiency in responding to the prevailing climate, was a physical delineation of the concept of privacy, where streets were well-defined at the three-dimensional scale to accommodate this lifestyle need.

Regardless of such debate about the emergence of the traditional Arab city, it is generally accepted that the primary factor which influenced the formation of the irregular pattern was the concept of “*reviving*” (or rehabilitation) of the vacant land surrounding private properties, which is directly derived from the Islamic teachings (Akbar, 2005). Accordingly, the traditional built environment, including streets, was not, in reality, haphazardly designed – these streets were an intrinsic part of the quality of life, full of communication tools.

4.2.3 Outdoor public spaces and the role of streets in the traditional built environment of Saudi Arabia

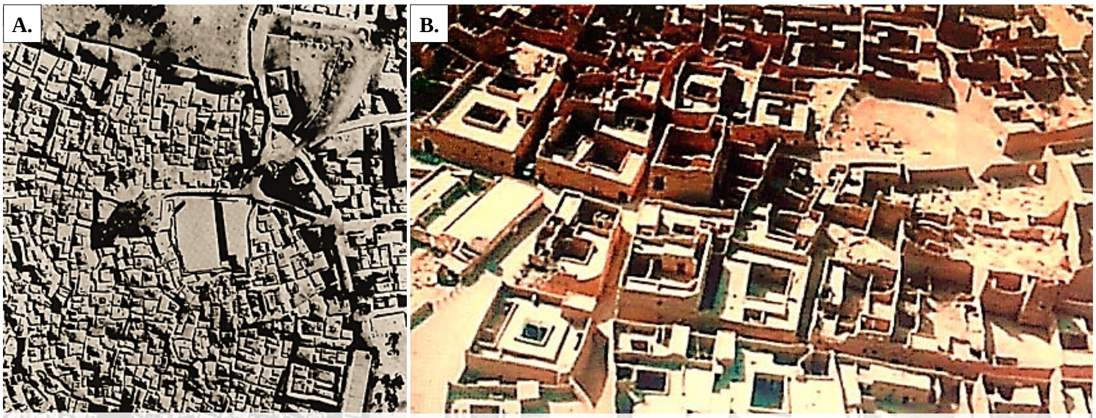
(1) Spatial configuration

Some of the works mentioned above which concentrate on tracing the evolution processes of the Saudi city agree that the Kingdom, before the oil discovery, had undergone two urban growth patterns:

a) The planned city in accordance with the Islamic culture, and
b) The spontaneously designed and incrementally grown morphology out of the older areas, following principles of the first pattern.

Tracing the formation process of the first pattern reveals the astonishing similarity in urban practices and concepts across the country. Although some variations existed (e.g. orientation, street width ratio to dwellings’ heights), the communication system, in the form of the design vocabulary developed by the traditional city, has worked on unifying the built form and its constituents physically and spatially (Hakim, 1989).

For example, one of the basic features in the traditional city was the centric-based urban structure. Although some sceptics point out it was more functional than expressionist in character (Kennedy, 1985), the form is widely accepted as a strong design vocabulary or physical manifestation of some of the Islamic basics (Hakim, 1989; Akbar, 2005). Specifically, the organisation and clustering of the city was typically positioned around a main central area (sometimes more than one but with different sizes) starting from the scale of the dwellings (courtyards) to the city-wide scale (e.g. mosque, ruler's palace, central thoroughfare for commercial activities). Thus, social, commercial, residential and other activities were often spread out of the centre to the periphery or from the 'inside' to the 'outside' (Figure 4.2) (Jaber, 2013).



A. Old part of Unayzah was built around the central mosque, KSA.

B. The open courtyard houses show how the traditional city was coherently linked and socially solidified. Old Riyadh, KSA.

Figure 4.2 Centrality in design is a physical translation of some of the Islamic principles affecting people's life (Source: a) Hakim, 1989: 89; b) Aina et al., 2013: 534)

Bianca (2000) describes the physical coherence of such a built environment as an outcome of the graded articulation of a series of polarities, between 'included' and 'excluded' or 'public' and 'private'. To exemplify this relation, the frontal space of the house (i.e. street) is a 'public' space to pass through but 'private' in relation to the social uses and as an extension for the dwellings overlooking the space, thus no wonder it was classified as semi-private. The same holds true for other spaces, such as the dwelling's courtyard that was an 'outside' space compared to the surrounding rooms, whereas 'inside' in relation to the house as a whole.

Such a spatial organisation was argued as an inherent quality of the concept of the 'centrality', derived from the Islamic culture where the values of the Holy Quran and

Prophet Mohammed's sayings, deeds and lifestyle are the centric guidelines and sources for every Muslim. Such urban activities often lead to the compact form, and hence other socio-cultural aspects, design vocabulary or qualities (e.g. privacy, synergy, collaboration, mutual support) that became correlated with Islam (Akbar, 2005).

On the other hand, the more spontaneously-generated pattern b) has been acknowledged to be the most predominant growth model in the modern history of Saudi Arabia until the advent of the car; hence it was seen as a major source of conflict with the arrival of the car, and its survival became threatened (Elsheshtawy, 2008). As this was the case, "The connection with everyday activities in the street was lost in favour of more mobility and opportunities for engagement without the locality. This led to an early transition towards modernity and disjuncture with the notion of locality and social coherence" (Abdelmonem, 2015: 28).

(2) Types of outdoor spaces

The layout of the traditional city had perhaps limited the construction of public spaces, except streets. However, the concept of outdoor public places was confined to spaces within neighbourhoods as tiny pockets (cul-de-sac type) for a group of houses. Although these spaces varied in size and orientation, they were small and semi-private. Other patterns of public spaces also existed, though limited in number, and were relatively large-scale spaces in the form of market squares.

Such limitations could be attributed to the reliance on the compact model that produced skinny and organic street patterns. In addition to its representation of certain socio-cultural values, this urban layout was adopted: (a) to reduce the amount of buildings' surfaces exposed to direct solar radiation; (b) to create a wind tunnel to mitigate weather conditions (Alznafer, 2014); (c) as a result of the agricultural activities and water resources on the outskirts of towns; and (d) for security and defence. This was also coupled with reducing the amount of light pouring into the different streets, to show their importance, in order to guide people from the more public and well-lit wide streets to the more private, narrow and less luminous streets (Petruccioli, 2007).

(3) Streets in the traditional context

The design criteria above may have collectively weakened the need for outdoor public spaces other than streets, which occupied almost 12.5% of the gross built up area (Hakim, 1989). Owing to this compactness, the street space was often designed as a three-dimensional environment in a responsive way to pedestrians' convenience of movement (Al-Hathloul, 1981). For example, most traditional streets incorporated elements above the street, known as the concept of '*sabat*', which is a second floor chamber bridging the street so as to show the relationship of the dwellers on both sides of the street (Figure 4.3).

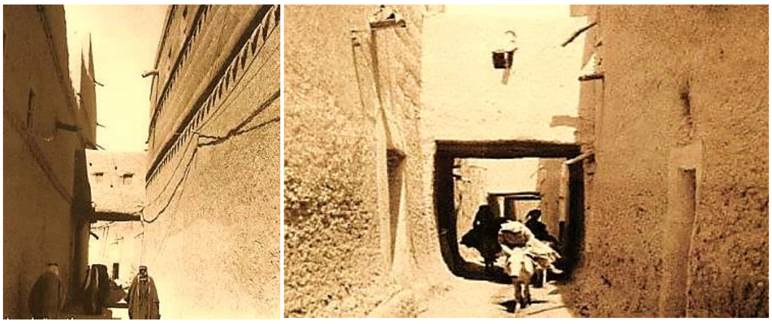


Figure 4.3 The concept of *sabat* over streets in Riyadh in 1937

As much as this concept was accepted as a design intervention responding to the compactness of the traditional city, by providing alternative space for socio-cultural needs, equally, it was functionally providing additional shade to the space underneath. Interestingly, the concept of *sabat* made it possible for residents, mainly women, to pass from one house to the other without having to use the street. Such a use of the entire street environment has somehow divided the city space into two realms based on gender: while women occupied the top space, the streets belonged to men at the bottom (Jaber, 2013).

On the basis of this approach, the interaction between the dwellings and pedestrians on streets was an effective design vocabulary, which contributed in shaping outdoor public spaces, and eventually to enriching the life outdoors. Streets were the primary everyday public landscape, where various social behaviours and cultural activities formed the central part of the Saudis' life out of doors. They were not only an access to the different parts of the city, but rather, the container for neighbours to socialise, participate in events or just have a change from the atmosphere of the house.

(4) Characteristics of street design

Several criteria controlled the design of the street space, ranging from regulating the vertical and horizontal dimensions to the hierarchy of the street network. For example, street width was originally the distance of respect between different tribes that took control of lands and was laid out through consensus between the heads of those tribes (Jaber, 2013). On another hand, street layout was typically developed from a central node (e.g. mosques) in different directions, hence forming the main thoroughfares of the city, where the tribes were usually inhabiting the lands in between. Secondary streets were subsequently formed by those tribes, either parallel to the main thoroughfares or extended irregularly between them (Akbar, 2005).

Moreover, street typologies were primarily of two types: (a) the through and open-ended streets, which were the public right of way, and (b) the “cul-de-sac which, according to Islamic law, is considered to be the private property” of the residents overlooking its space (Hakim, 1989: 99). Each of these two types has its own design characteristics that are summarised as follows:

a) Public through and open-ended streets:

- Mainly used for large-scale commercial, social and religious activities,
- More permeable space open to all, including travellers,
- The camel was the primary means of transport, until around the 1920s, which had a major impact on street design (Hakim, 1989). Street dimensions were based on allowing porters and animals, with ease of transport of goods, hence a minimum of seven cubits (3.20-3.50m) was required horizontally and vertically (Al-Hathloul, 1981; Al-Said, 1992) so as to be wide enough for two fully loaded camels to pass without hindrance (Figure 4.4). This further demonstrates the role of Islam in shaping traditional cities in reference to the Prophet’s guidelines: “If you disagreed about the width of a street, make it seven cubits” (cited by Ibn Majah via lbn Abbas). However, in practice, streets of this type varied in width (2-6m) and sometimes width varied within the same street.

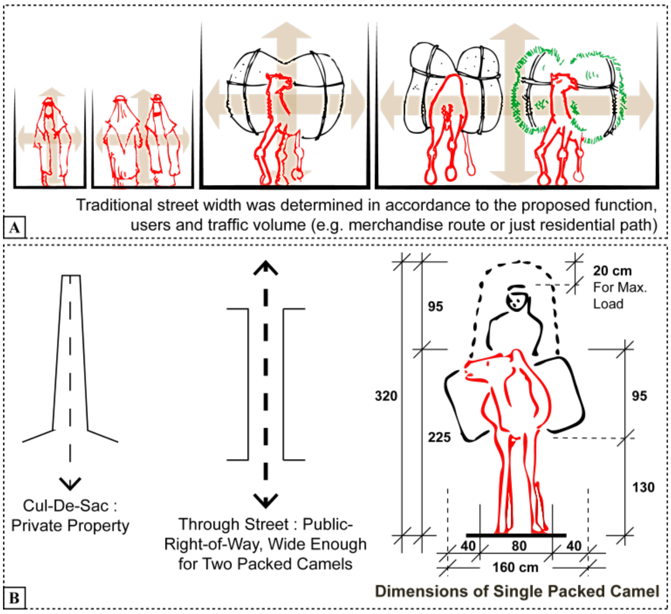


Figure 4.4 Design considerations of the traditional street and width definition (Source: reproduced by the author, after a) Al-Said, 1992: 121; b) Hakim, 1989: 90)

b) Private cul-de-sacs:

- These are 'dead-end' residential accesses, and the smallest component in the street hierarchy, typically maintained by the surrounding houses for social activities (Hakim, 1989),
- Their configuration can be very complex; for example, a straight route can take a sudden right-angle or even Y- and U-shaped turns, and sometimes were bridged by *sabat* so one can feel the space is like a tunnel,
- The scale of the space was exclusively pedestrian-oriented and varied in width from 0.5 to 3m, so that it was easily controlled by means of a gate (Jaber, 2013),
- Out of the 12.5% that streets occupied of the city, only 13.3% of these were cul-de-sacs serving 28.5% of all buildings, "i.e. a relatively low proportion of cul-de-sacs serving a high proportion of buildings" (Hakim, 1989: 101),
- One of the major aspects characterising this type of street was the respect for privacy which dictated the design of buildings overlooking the space. For example, windows overlooking the space were located above eye level (≈ 2m) to prevent views into the houses from the street. Doorways of two different houses were designed in a way hindering the direct view into the inner courtyard spaces in which women spend much of their time (BaHammam, 2006; Petruccioli, 2007).

4.2.4 Historical overview of transformation of the traditional street layout (the beginning of change)

The earliest evidence of a noticeable change to the traditional fabric can be traced back to 1904 in Hofuf city, during the Ottoman rule (Al-Naim, 2008a). Because history has left few sources documenting other urban activities (Alangari, 1996), the model found in Hofuf is recognised to be the first attempt to adopt a planned neighbourhood according to the gridiron pattern. However, this attempt was discontinued until the oil was discovered by U.S. companies. The advent of these companies was the most crucial juncture, which has deeply impacted the transformation of the traditional fabric into a completely new city image.

Given the oil concession, which was exclusive to ARAMCO from 1933, the company introduced, for the first time in the country, new concepts, forms, materials and images of urban spaces and dwellings, as well as lifestyles (Figure 4.5). This was initiated through a housing project called 'senior staff camp', which was built between 1938 and 1944, to house western staff, engineers and their dependents (Al-Hathloul, 1981). This is considered the historical reference point for the contemporary built environment (Al-Naim, 2008a).

A. The senior staff camp: lush and green grass lawns, shading trees and flowering shrubs in the middle of a desert (1950; 2008)

B. Bowling alley, Dhahran (1949)

C. Aramco employees at Half-Moon beach, south Dhahran (1958)

Figure 4.5 The new urban image and some of the new lifestyles introduced to the Kingdom by ARAMCO between 1930s and 1950s (Source: www.aramcoexpats.com, 2008)

Soon after the establishment of preparations necessary for the development of this discovery, the next essential activity for both ARAMCO and the government was building supportive facilities. This required a workforce to be hired. The area became a preferred destination for native people and for those from abroad seeking for job opportunities. At that time, the Eastern region was a location of scattered nomadic tribes living in tents, a few existing tiny hamlets living on fishing and pearling, including Dammam, and two compact, traditionally-designed villages depending on farming: Qatif and Hofuf. While these latter two towns were located at a distance from the oil fields, Dammam was the nearest potential settlement to accommodate the increasing number of workers (Al-Said, 1992).

However, according to Al-Hathloul (1981), Dammam was not a close enough village to be relied upon. Therefore, workers settled at a relatively short distance from the oil fields in very basic huts known as ‘Barasty’ (made out of woven palm fronds), forming their own camp. Indeed, as fast as the oil-producing industry grew, so the number of people arriving the area grew, and the population was doubled, thus the region became rapidly more densely populated. This situation created a haphazard urban sprawl everywhere, in all directions (Al-Naim, 2008a). Dammam began to expand its old tenuous fabric outwards in a chaotic configuration because people “took over any available land and erected basic shelters and fences of local materials” (Al-Hathloul, 1981: 145).

This unplanned growth, combined with the establishment of Khobar settlement in the same chaotic fashion, was not welcomed, either by the government or ARAMCO (Al-Naim, 2008b). Therefore, in 1947 the government commissioned ARAMCO to help in controlling these two emerging settlements. Given that ARAMCO was administered by American engineers, the proposed plan was a western model. This participation was the milestone for introducing the first planned city in Saudi Arabia, which exclusively adopted the gridiron pattern; hence it was the actual starting point of the modern city form. When the grid layout was introduced to Dammam, the approach was to isolate the existing fabric and disregard any previous street patterns (Figure 4.6). With N-S street orientation and width ranging 20-30m; “no attempt was made to adapt the new street pattern to the old one” (Al-Hathloul, 1981: 146).

Figure 4.6 First emergence of the gridiron pattern in Dammam (Source: Hakim, 1989: 94)

This correspondingly allowed for the actual beginning of the era of the car, because the gridiron system was originally planned to give much priority to means of transport (Alznafer, 2014). Subsequently, ARAMCO continued developing Dammam and Khobar, both of which led the way in developing other parts of the Kingdom, whether directly, consciously, or not (Al-Hathloul, 1981). For example, Riyadh, being the capital, was the second strategic area expected to witness major changes. The construction of Al-Malaz residential project in 1953 and the master plan developed by Doxiadis Associates in 1971 imposed a strict super grid structure on the city. This is because the gridiron model was seen to be “the most desirable pattern to be followed in the planning of Riyadh as well as in other cities of the country” (Al-Naim, 2008a: 138). Such urban activities consisted of a hierarchical street network ranging from 18-55m in width. This was combined with introducing new building codes and regulations.

All the above urban processes ensured the rapid transformation of Saudi Arabia from merely a desert kingdom with mud-built towns into a modern nation-state, and hence brought different perceptions to the meaning of a city. However, seemingly, the rapid pace of development did not allow the government to assess the consequences of the new urban environment on people’s lifestyles. Mimicking the gridiron pattern as it is, without paying any careful attention to the adjustments necessary for conditions of the local context, and the associated codes and regulations may have collectively triggered the beginning of the gradual deterioration of pedestrian space.

4.3 PART TWO: Exploration into the Socio-cultural Aspects most relevant to Outdoor Spaces

Every society has its own culture, therefore its own way of living and interaction. The culture of the Saudi society has been largely influenced by (a) the religion of Islam, (b) the role of history, (c) its geographical location and (d) its traditions, which, hence, make it different from other cultures. It has been also recognised that formation of the traditional Saudi built environment was largely influenced by certain socio-cultural aspects (BaHammam, 2006). The impact of such aspects has been extensively covered in relation to the formation and transformation of the traditional dwelling (e.g. Al-Hathloul, 1981; Al-said, 1992; Akbar, 2005; BaHammam, 2006; Al-Naim, 2008a; Jaber, 2013).

However, only two PhD studies in landscape architecture have dedicated their efforts to exploring role of the socio-cultural attributes on the use and design of outdoor spaces, with special attention to recreational activities in public gardens (BaHammam, 1995) and seafronts (Al-Abdullah, 1998). Subsequently, two Master's dissertations, in the same discipline, conducted by Umran (2002) and Al Sarhani (2004) partially studied the impact of the socio-cultural attributes on the design of seafront developments in the Eastern Province. Although they focused on sedentary activities in selected public urban spaces, all the four studies put emphasis on how certain socio-cultural attributes in the Saudi context can play a great influence on users' behaviour, the use of such spaces and eventually on design considerations.

4.3.1 Sensitivity to be seen performing physical activities out of doors

The conclusions of the above mentioned studies reconfirm Rapoport's argument (1991; 1993) that the characteristics and qualities of the physical environment can be supportive of or inhibiting towards behaviours. To exemplify this relation, BaHammam (1995) underlines that the culture of Saudis has been recognised to be very sensitive towards being seen practising certain outdoor physical activities, particularly for the older generation (Figure 4.7), thus some techniques of providing visual barriers are recommended. On this basis, pedestrians tend to choose evenings for walking due to the lower visibility (Al-Thukair, 2009). Nevertheless, during the fieldwork activities of the present study, it was evident that this aspect is changing (Figure 4.8), demonstrating that the notion that behaviour change can be achieved in Saudi Arabia if certain facilitating conditions, compatible with the public's preferences, are incorporated.

A. Caricature published in Alriyadh newspaper shows a Saudi man walking while his face is veiled so that nobody can recognise him (Source: BaHammam, 1995: 144)

B. Twenty years later, the same behavioural manifestation can be recognised (Source: the author, 2015)

Figure 4.7 Two different periods show a Saudi man walking with a masked face reflect the extent to which walking is still primarily associated with some socio-cultural aspects

Figure 4.8 Sensitivity of the Saudis towards being seen practising some physical activities out of doors is changing, almost for all generations and genders, although outside the street space (Source: the author)

4.3.2 Male-female interaction

With a simple observation of the lifestyle in the KSA, it is noticeable that communication and interaction between the opposite sexes is the most dominant socio-cultural aspect, both indoors and outdoors. Therefore, it is of a great importance to further clarify this aspect, due to its relevance to the findings of the study, which demonstrates the extent to which walking on Saudi streets is very sensitive to the socio-cultural context. Almost certainly, in situations where women are sharing the same space with men, one of the inherent shared rules is the strict "physical gender segregation", which is considered binding on any member of the society so that people are expected to observe and follow this rule. This means that relations and interactions between men and women who are strangers (i.e. without family ties) are forbidden under the Islamic law, and therefore must not involve physical contact with each other[33].

Some studies attribute the origin of this aspect, and thus its adoption as a lifestyle, to "the interpretation of the Islamic religion in Saudi Arabia" (Alkahtani et al., 2013: 205). Whatever the original source, the reality is that one can see clear implications of such a behavioural code in the public spaces. It is frequently observed when male pedestrians are faced with females on pavements: men usually tend to step off the pavement onto the road, if there is not enough room to accommodate both, allowing and prioritising the passage of females.

Likewise, when women are approaching a group of males or walk near male-oriented activities (e.g. gents' tailors, tobacco or barber shops), females, in an automatic reaction, turn into the edge of the kerb. Sometimes, they even move onto the road surface in order to avoid any form of physical contact with males. Consequently, when the pavement is narrow or its physical components do not seriously consider such an issue, female pedestrians often tend to behave unexpectedly, interact with the street space differently and even haphazardly, where they often become vulnerable to hazardous conditions as a result of direct confrontation with cars (Figure 4.9).

Figure 4.9 Women's withdrawal from using the pavement onto the road is often attributed to the narrow width, encroachments on the space and/or domination of male-oriented activities (Source: the author)

[33] With few exceptions under, for example, medical conditions and emergencies.

This part of the section has partly answered research question 3, regarding the influence of certain socio-cultural aspects on walking in Saudi Arabia, for which the types of behaviours described above, have implications or connotations. The way in which women behave in streets not only reflects some of the socio-cultural attributes of interactions between the opposite genders, but also significantly demonstrates that the existing pavements with their design characteristics are deficient in supporting needs of all pedestrians simultaneously. Therefore, both sexes often tend to find alternative places (Figure 4.10) that fulfil their walking purposes (e.g. for recreation, sport, health or social interaction).

However, this tendency may expose them to risk in certain circumstances, particularly when appropriate alternatives are not available or easily accessible. For example, it is often observed that pedestrians, regardless of gender and age, go for walks along main streets (Figure 4.11), thus becoming prone to accidents and various types of pollution. This indeed echoes the thesis of Rapoport who claims that:

> "Cultural variables are primary for any activity, including walking and others, occurring in streets. It is culture that structures behaviour and helps explain the use or non-use of streets […] Thus, the use of streets by pedestrians is primarily culturally based […] Physical environments, however, can be supportive or inhibiting" (Rapoport, 1991: 83).

Figure 4.10 Failure to observe the nature and impact of the relationship between men and women on the design of streets for walking may greatly contribute in pushing the pedestrians outside the street space into other urban places (Source: the author)

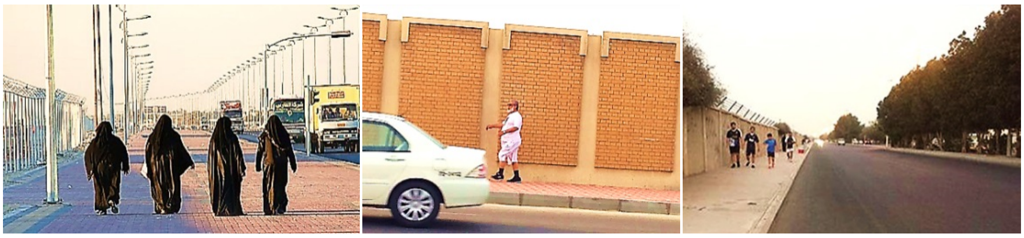


Figure 4.11 The design of neighbourhoods' pavements in a way unresponsive to certain socio-cultural aspects may interpret the pedestrians' tendency for walking along main streets, which are typically wider, well-lit, well-paved and encroachment-free

4.3.3 Privacy and distance regulation – personal space

According to BaHammam (2006), the interaction of social norms, cultural and religious values, together with physical considerations, has established a significant influence on style of the Saudi built environment. He found that behavioural factors "include a wide range of human concerns, responses and attitudes. Privacy is one of these factors and, because of its strong role in Saudi society; it has become the determining behavioural factor in shaping the design of the built environment" (BaHammam, 2006: 103). Similarly, Gehl (2010) emphasises that human beings are innately a "do-not-touch" species; thus, wherever physically possible, they tend to keep a physical distance from each other and seek to maintain the distance that keeps any situation secure and comfortable. This attitude reflects their desire to achieve the feeling of an optimal level of privacy. Gehl further describes this distance as:

> "a zone where the presence of others is not wanted except by special invitation. The individual guards this zone, which can be described as an invisible, personal bubble. Everyone else is kept, quite literally, at arm's length [...] or at the very least don't touch distance" (Gehl, 2010: 49).

BaHammam (1995; 2006) further asserts that the desire for personal space as a form of physical privacy is a significant socio-cultural factor that influences almost everything in the Saudi society, including all manner of outdoor spaces and lifestyles. For example, one can clearly see this factor among people picnicking at the beach or in parks, sitting on benches along waterfronts or in a queue waiting to buy entry tickets to amusement parks. Rapoport (2005: 81) defines privacy as controlling unwanted interactions, and states that it involves rules and manners. He further argues that the notion of privacy is about the definition of 'interaction' and 'unwanted', specifically, between whom and whom, when, where and why.

Altman maintains that “The desired level of privacy is achieved through mechanisms of personal space and territorial behaviour” (Altman, 1975: 3), and further argues that withdrawal from public life can be attributed to failing to achieve a desired level of privacy. He continues: “Privacy is defined as an interpersonal boundary-control process, which paces and regulates interaction with others” (Altman, 1975: 10). Oseland (1993) refers to privacy as a reciprocal interaction between the type of space and activities performed within the space, Alexander (1977: 610), who addressed privacy through the principle of a “privacy gradient”, focuses more on the relationship between the space and its users. Accordingly, there is a need to study walking, as performed by the actual pedestrians in their actual space, and hence identify the degree of privacy the space affords for such an activity.

Different forms of privacy are demanded by different cultures around the world, and hence different degrees of privacy. Forms of privacy in the Saudi society are the result of instruction based on deeply held religious beliefs; thus, as an Islamic society; the hierarchy of privacy in the Kingdom is regulated or governed according to the Islamic teachings (BaHammam, 2006). In this regard, Islamic teachings require people to maintain a boundary or physical distance with the opposite gender, to prevent any form of promiscuity from either side[34]. For this reason, it is not uncommon to see a husband walk behind his wife, so as to define and protect her own personal space in public (Figure 4.12).

Such an observation illustrates Horowitz’s (1970) findings, which demonstrated that personal space is larger towards the front of the person, somewhat reduced behind and even smaller at the sides. He also observed that the personal space depends on the gender of the approaching and the approached person. On this basis, BaHammam (2006) identified two forms of privacy: female privacy and family privacy, both of which affect the shape and design of the built environment, both indoors and outdoors. However, family privacy is more related to the dwelling, while female privacy is equally important to indoor and outdoor spaces.

[34] Nevertheless, there are very limited situations where personal space can be ignored or neglected. Specifically, a group of people praying in a mosque or performing Hajj (pilgrimage) will inevitably stand shoulder-to-shoulder, but certainly the same people would not tolerate or accept the same distance in different situations.

Figure 4.12 A typical Saudi husband walks behind his wife, which can be interpreted as a behavioural form that defines and protects her personal space (Source: the author)

Another relevant example is the boundary controls or distance regulation between picnickers in outdoor recreational areas, whether of families-to-families, families-to-singles or singles-to-singles. For example, BaHammam (1995), in selected public gardens in Riyadh, reported that the average preferable distance ranged between 8 to 12m (Figure 4.13). Alabdullah (1998), in his study dedicated to Dammam recreational seafronts, observed that the average preferable distances ranges between 15m at peak times with visual barriers (like windbreakers or cars) and up to 60m or more at off-peak times and without visual barriers.

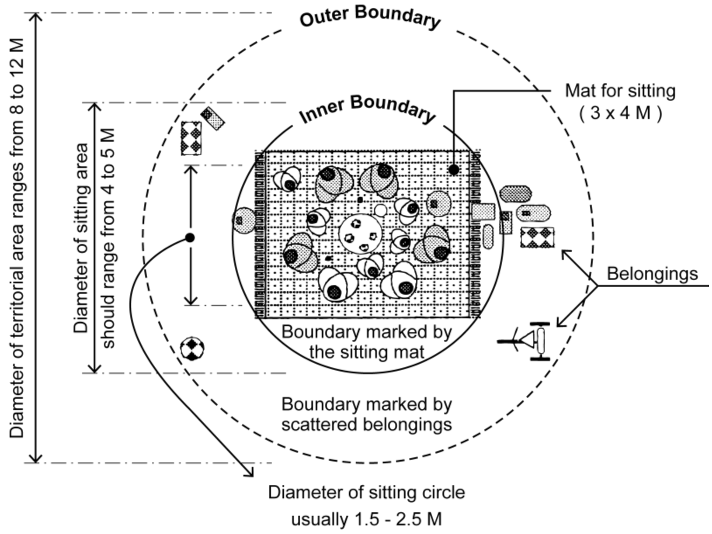


Figure 4.13 Levels of boundary control through arrangements of belongings, in sitting situations in public gardens in Riyadh, which is typically adopted as a way of marking physical privacy and personal space (Source: BaHammam, 1995: 149, 153 & 208)

However, two Master's studies showed such preferable distances are shrinking. Umran (2002) and Al Sarhani (2004) focused on sedentary recreational activities along waterfronts in Khobar and Jubail, near Dammam. Both reported the observed distances in the previous dissertations dramatically decreased to an average of 12m without visual barriers and 2.5m with a visual barrier. These examples are presented here not only to show how the theory of personal space is a very sensitive issue to the Saudi context, but also to demonstrate that a cultural shift has occurred to lifestyle attributes of outdoor users in a short time. However, this aspect has never been explored and measured among pedestrians.

4.4 PART THREE: The Case of Dammam City

4.4.1 Overview

This section of the chapter continues by reviewing the factors behind the evolution of Dammam city from the first stages of its formation (described under section 4.2.4) down to an analysis of the existing conditions of the street space. The purpose behind such an approach is to produce a clear comprehension of how the earlier vibrant street space has been transformed into a pedestrian-hostile environment. This part also documents the recent urban processes aimed towards street revitalisation. This section responds to objective (3) in Section 1.8 of Chapter One, which is:

> To analyse the physical and spatial characteristics of the existing street space in Dammam and how this space responds to the prevailing climate conditions and the most pertinent outdoor related socio-cultural aspects for the Saudi context.

Additionally, according to Gehl and Svarre (2013), outdoor human activities often leave traces, which can give researchers deep insights into the interaction between activities and the use of urban spaces. Thus, selection of the appropriate tools to document such aspects is essential. Among the simple tools is photography, which has been found to be a very effective technique in studying public life in urban spaces, as well as to enliven and recall data. It serves as a visual surrogate which enables researchers to undertake later analysis without their physical presence in the actual setting. By later studying photographs:

> "it is possible to discover new connections or to go into detail with otherwise complex city situations that are difficult to fully comprehend with the naked eye" (Gehl & Svarre, 2013: 31).

Combined with benefits of photography is the use of mapping and sections (Marshall, 2005), all of which are employed in this part to gain deep insights into the associated aspects affecting pedestrians and outdoor walking. Moreover, it is essential to first outline some relevant data, and thus, as a major component in this thesis, the following sub-sections provide a detailed picture of the climatic conditions of Dammam, in addition to its geographical and environmental aspects.

4.4.2 Location, area, population and landscape features

Dammam is located on a sandy beach that lies between longitude of E50°0.00' and E50°10.00' and between latitude of N26°25.00' and N26°30.00'. The northern and eastern boundaries are the long coast of the Arabian Gulf. Qatif and Tarout Island are also located north. To the west is the great sand of the Dahna Desert, and to the south are the cities of Dhahran and Khobar. Bahrain to the south-east is linked with Dammam Metropolitan by a causeway. The location of the city has always made it a very important place; thus it is dubbed as the "Eastern Gate of the Kingdom".

According to Al-Shuaiby (1976), Dammam occupied an area of less than 0.7km^2 around 1947, and increased to 15km^2 by the 1970s. He also mentions that the population, was estimated at around 1350 people in 1935, and reached 43,000 by 1970, recording a growth rate of 95.5% during this period. In this context, Satterthwaite (2005: 11) listed Dammam among the world's fastest growing cities between 1950 and 2000. Today, the city has expanded to over 800km^2 (Wikipedia, 2016), and has already exceeded one million inhabitants, and is hence classified as the fifth largest Saudi city in terms of the size of population (CDSI, 2013).

Topographically, the city lacks distinctive terrains that could contribute to enriching its physical appearance. Almost all parts of Dammam lie on a very flat and low-lying coastal plain that slopes gently from the sandy desert on the west towards the Gulf shoreline on the east, with an average of less than 1% slope per linear kilometre (Al-Abdullah, 1998). However, starting from the southern part of the city towards Dhahran area, rocky outcrops and somewhat hilly terrain become apparent. Such topographic characteristics have limited the soil types to sandy and Sabkhas, both of which usually limit the growth and diversity of vegetation, without soil treatment.

4.4.3 Climate characteristics

All information used here is based on online data from the meteorological station at King Fahd International Airport (KFIA), located around 30km to the west of the city boundary. Therefore, there is an essential need, during the data collection process, to carry out field measurements for more accurate data on the urban environment, which is more likely to differ from the conditions at the meteorological station – as it has been already observed by Nikolopoulou and Lykoudis (2006).

According to the Köppen-Geiger climate classification (Peel et al., 2007), the climate of Saudi Arabia is generally categorised under the climate zone of [*BWh*], that is, influenced by hot-arid conditions (Figure 4.14). Countries located within this zone are mainly classified as deserts and characterised by extreme high temperatures, extreme diurnal temperature differences, low humidity, high evaporation and scarce precipitation. However, given the massive land area of the Kingdom, the attributes of the climate of Dammam slightly differ from these, in experiencing high levels of humidity, owing to its geographical location and topographical characteristics. The Encyclopaedia Britannica (2014) describes the climate of Dammam as "notoriously unpleasant".

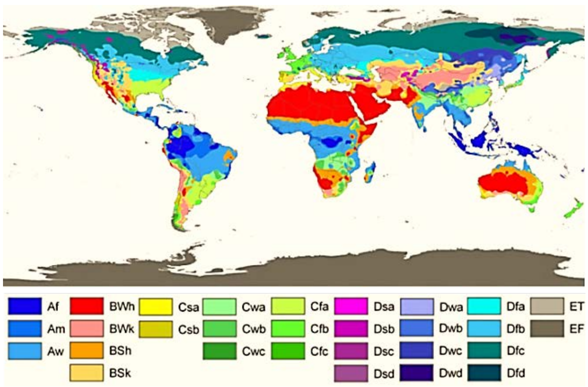


Figure 4.14 The Köppen-Geiger classification for climate zones (Source: Peel et al., 2007: 1642)

(1) Air Temperature (Ta)

Dammam is extremely hot under direct sunlight during the summer months that last from May to October. The city is considered among a few areas in the world where it is not unusual for Ta to exceed 50°C on the hottest days from June to August, and hence the summer is the season that brings more discomfort for pedestrians. The climate during the rest of the year ranges between relatively temperate to warm.

However, the city may witness very low Ta during winter months, where it commonly reaches to as low as around 5°C and may drop to around 0°C some days on the outskirts of the city.

Table 4-1 summarises the air temperature data for a 10-year period (2006-2016). The average annual temperature was 27.2°C, and the average temperature of summer months was 35.1°C. January, in contrast, was the coldest month with the average lowest temperatures at 5°C and the lowest recorded temperature was 2°C, in January 2012. The highest recorded air temperature reached 50°C in June 2009.

Table 4-1 Summary of Ta history for Dammam, between 2006 and 2016 (Source: the author)

Month	Record High °C	Avg. Max °C	Avg. Mean °C	Avg. Min °C	Record Low °C
Jan	31	28.7	15.7	5.0	2.0
Feb	36	31.8	17.8	6.5	5.0
March	39	37.2	21.5	9.3	6.0
April	45	41.8	27.0	15.0	13.0
May	48	46.0	32.5	21.2	19.0
June	50	47.8	35.8	25.2	24.0
July	49	47.7	37.2	25.8	22.0
Aug	48	47.2	36.6	26.0	24.0
Sept	47	45.5	33.4	22.2	20.0
Oct	43	41.3	29.1	18.3	16.0
Nov	38	35.4	22.3	11.2	8.0
Dec	32	28.8	17.1	7.2	5.0

(2) Relative Humidity (RH)

Since the early 19th century, it has always been recognised that Ta is not the only cause of thermal sensation, that humidity is a contributing factor (Auliciems & Szokolay, 2007). In fact, humidity is one of the most important environmental factors in determining how climate conditions feel to a person experiencing them. Hot and humid days feel even hotter than hot and dry days, because the high level of water content in humid air discourages the evaporation of sweat from the skin, thus greatly contributing to increase heat stress (Parsons, 2014). To exemplify this relation, the higher the air is humid, the less likely the human body will be able for perspiration efficiently, hence cooling the body fails. This means when the air is dry, Ta of about 40°C can be tolerated, but when the air is moisture laden, a Ta of 30°C can feel unbearable (Beer & Higgins, 2005). In this context, it is worth mentioning that:

> "skin moisture correlates well with warm discomfort and unpleasantness. It is rare for a sedentary or slightly active person to be comfortable with a skin wettedness greater than 25%. In addition to the perception of skin moisture, skin wettedness increases the friction between skin and fabrics, making clothing feel less pleasant and fabrics feel more coarse" (ASHRAE, 2009: 9.1-9.2).

This quotation is significantly pertinent to the case of Dammam, where the national costume for both genders involves covering most parts of the body, and hence contributes in increasing thermal discomfort under the hot and humid conditions the city witnesses. As a result of the geographical location of Dammam, on a relatively shallow and narrow marginal sea of the Arabian Gulf, combined with high temperature levels, RH becomes intense in Dammam, at high rates.

Bearing in mind that humidity correlates with air temperatures, the hottest hours of the day tend to be the least humid, and hence, the lower daily rates of RH typically occur during the daytime while the higher rates occur during the night. Applying this phenomenon, the least humid month is June, and the most humid month is January. Figure 4.15 illustrates the average RH for Dammam, based on the historical records for the period 2006-2016. The annual RH ranges from 15% (dry) to 90% (very humid), and rarely drops below 9% (very dry) or reaches 100%. The air is driest around 26 June with an average daily low that drops below 18%, and it is most humid around 15 January, with an average daily high that exceeds 84%.

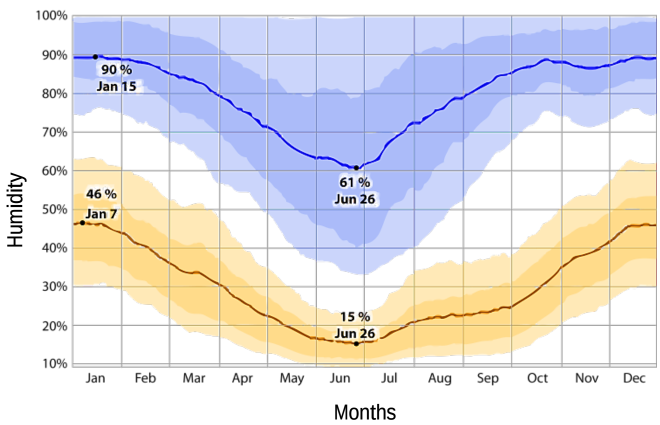


Figure 4.15 The average daily relative humidity in Dammam: average high (blue) and average low (brown), for the period 2006-2016 (Source: weatherspark.com)

(3) Wind characteristics (v)

Among all types of climatic environments, the hot-humid climate receives the largest number of discomfort adjectives, for example, *muggy*, *sticky*, *stifling*, *seething* or simply *sultry* (Olgyay, 1953; Auliciems & Szokolay, 2007). Many researchers refer this state of *stuffiness* to the lack of air movement under humid conditions, particularly in hot zones. This illustrates the close relationship between presence of air movement and humidity, and eventually its effect on thermal comfort.

Figure 4.16 below shows the relative frequency of wind speeds and directions for Dammam for a 10-year period (2006-2016). The annual wind speed typically varies from 0 to 10m/s with an average wind speed of 4.2m/s. About 17.2% of the time the air movement is calm, and rarely exceeds 13m/s. The highest average wind speed of 5m/s occurs in June, at which time the average daily maximum wind speed is 9m/s. The lowest average wind speed of 3m/s occurs in October, when the average daily maximum wind speed is 6m/s. The prevailing wind direction most often blows from the North to North-West. 21% of the time wind direction is from North-West, 19% from North and 17% from west. The wind is least often out of the south west, approximately 3% of the time.

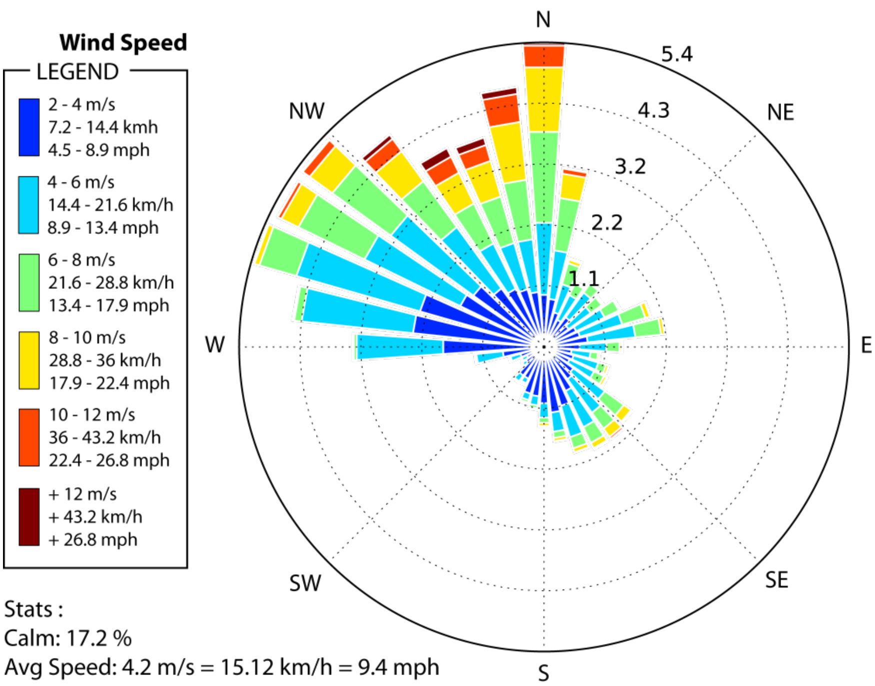


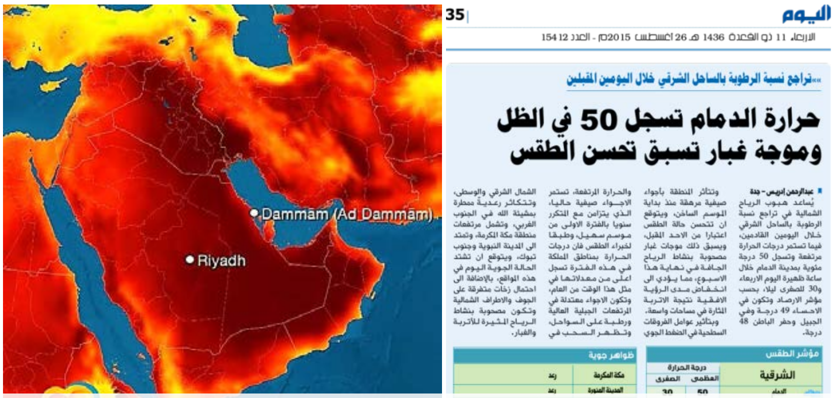
Figure 4.16 Wind-rose plot for Dammam showing how the wind speeds and the directional wind characteristics were typically distributed from Dec 2006 to Sep 2016 (Source: IEM, 2016)

(4) Impact of the climatic factors on the urban environment

According to the Saudi Presidency of Meteorology and Environment (PME), the daily peak of high temperatures usually occurs between 11am and 3pm. They attribute the high thermal sensation experienced as being typically associated with increased RH level during the day, which often leads to thermal stress. This may partly explain the lack of pedestrians in outdoor spaces of Dammam until late afternoon, and hence identifies the level of impact of climatic conditions on the use of streets by pedestrians.

Moreover, the PME seasonal report for summer 2015 (June-August) indicates that the surface temperatures, at 2m high, recorded rates relatively above the seasonal averages over Dammam (Figure 4.17/A). In addition to the influence of the climate factors, the PME links this increase to the observed rise in the cumulative impacts of the UHI phenomenon. The report attributes the formation of this phenomenon primarily to the lack of urban green cover and vegetation surrounding cities which could mitigate heat waves from deserts. That, coupled with anthropogenic heat release sources and low ventilation in urban areas, exacerbates the increasing temperatures.

In support of the PME report, Dammam witnessed, on 26th August 2015, an unprecedented increase in air temperatures, which reached slightly above 50°C in the shade (Figure 4.17/B). Such an increase, accompanied by high rates of humidity, may have contributed to some environmental impacts on both human and wildlife activities (Figure 4.18). For example, an overall withdrawal of motorists and pedestrians was clearly observed on that day. However, the pedestrians were the most affected, while motorists could tolerate the severe conditions, in their air-conditioned cars.



A. Higher surface temperatures compared to the seasonal averages at this time of the year (Source: Climate Saudi, 20th Aug. 2015)

B. Dammam recorded 50°C in the shade (Source: ALYAUM Newspaper, No. 15412, 26th Aug. 2015)

Figure 4.17 Dammam experienced a record in high temperatures during summer 2015

A. King Fahd Rd., a major arterial road connects cities of Dammam Metropolitan, around 2 pm on 26th Aug. 2015.

B. Dammam Corniche area, afternoon 26th Aug. 2015

Figure 4.18 Fish deaths and lack of outdoor life in Dammam, afternoon 26th Aug. 2015, were interpreted as a result of the increase of temperatures (Source: courtesy of Eng. Mamdouh, 2015)

4.4.4 Morphological analysis: the evolution of streets in Dammam

In the past six decades, Dammam has been transformed from a tiny fishing and pearling hamlet into a large modern capital of the Eastern Province. The urban form has changed from that of the compact, organic and narrow Middle Eastern city into one that hardly differs from any industrialised cities in the most developed countries. The objective of studying how the urban morphology has evolved and how street patterns have changed through history can provide a thorough understanding on the factors that led to the existing conditions of the street space. In fact, “Urban form can only be understood historically since the elements of which it is comprised undergo continuous transformation and replacement” (Moudon, 1997: 7). This means the city is not a static entity but is in a state of continuous evolution.

Therefore, among the four fundamental morphological elements[35] defined by Conzen (1960), the street pattern tends to be the most enduring element (Carmona et al., 2010). The original urban form of Dammam still exists today, and maintains traces of the urban morphological changes since its early formation, which can be clearly traced through the evolution of street patterns. By colouring the core area of the city plan, three major historical periods, and hence street layouts were identified, where each period exhibits its distinctive characteristics (Figure 4.19). The distinctive features of these periods are summarised below.

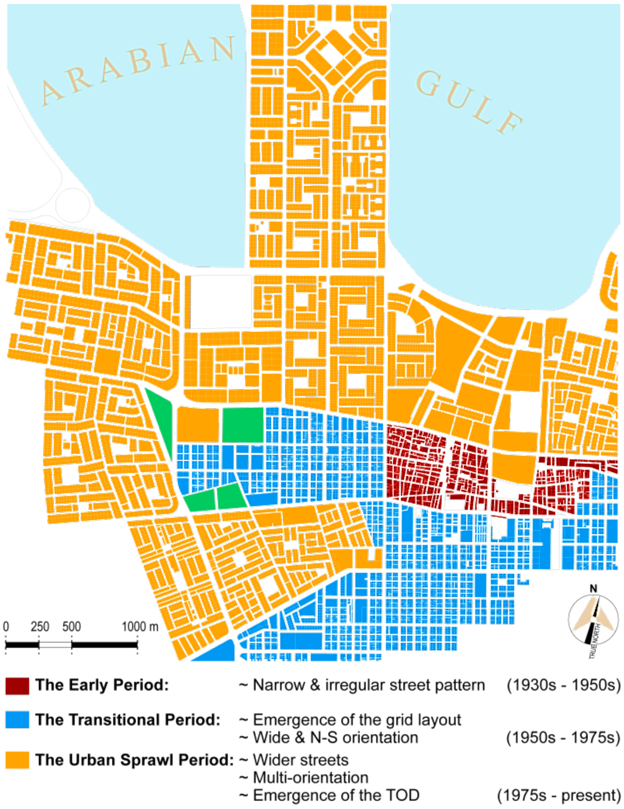


Figure 4.19 Part of the Dammam map, showing the evolution of street patterns (Source: the author)

(1) The early period; before and during the oil discovery (1930s-1950s):

a. The city followed the prevailing planning practices of the Gulf region and the urban growth was parallel to the original shoreline. The city was compact: spaces between dwellings were tiny, streets were narrow and irregular and 'Barasty' was the typical housing style, in irregular land plots.

[35] These are: buildings, open spaces, plots or lots and streets.

b. The street served as the major public space for outdoor life, and remains in its original pattern until today.

c. Given that there was neither government administration nor official urban planning to control the city layout and growth, the factors that influenced the form of the street system can be attributed to the footpaths of the first dwellers or simply climatic conditions. What is obvious in this period is that N-S streets were generally wider than E-W streets.

d. Main streets were not only distinguishable in terms of width, during the olden days, but were also the most important in terms of their spatial structure, socio-cultural functions and provision for trading activities. They were N-S oriented linking the city with the sea and maritime activities.

e. Secondary streets were either parallel or at right angles to the main streets.

f. Minor streets were either formed from the original footpaths or later, to link the main and secondary streets. These minor streets and lanes have formed the most delicate parts in the urban tissue.

g. Walking was the main lifestyle and basic form of transport. One could choose where to walk on the street, however, edge of the street was typically dedicated for women, while the middle was for men (BaHammam, 2006).

h. Pedestrians and animal-drawn vehicles shared the street space.

(2) The transitional period: emergence of the gridiron layout (1950s-1975s):

a. This is the first transformation process from the traditional pattern to setting up institutionalised regulations for buildings and planning. Regular block size, new dwelling styles and construction materials were introduced as a direct result of the western influence and the new socioeconomic status.

b. This period witnessed the first emergence of the grid plan, which was strictly imposed on the city. This means the grid layout, rather than being introduced to coexist or interweave with the previous street pattern, has completely isolated the old urban tissue. The urban area mainly stretched to the south towards ARAMCO. Streets were wide, straight and N-S oriented ranging from 20-30m in width. New streets were constructed to cut through the original urban tissue.

c. The original gridiron layout comprised of a large block size of 90 x 180m. After the accelerated growth and rapid attraction of population to the city, the governor of the Eastern Province requested ARAMCO to revise the proposed land subdivision plan (Al-Hathloul, 1981). The revision subdivided the existing block size into two smaller blocks (90 x 90m), thus generating alleys in-between, but the street width remained the same. A second revision led the original blocks to be subdivided again into 45 x 60m, making a final block size of 6 plots. What was obvious from this process is that E-W streets and alleys are wider than N-S ones, unlike the old streets in the original fabric.

d. The street layout was the major overall plan and served as the means to achieve the modern city and modern life. Thus, the car has gradually become the dominant mode of transport which replaced the long existing practice of walking.

e. The street space has been divided for cars and pedestrians, although the car has received a larger share, and the road surface was painted with markings for car lanes. Pedestrians have become confined to the pavement space.

f. Under planning and zoning regulations, the street's function of being a meeting and social place was diminished.

(3) The period of massive urban sprawl (1975s-present):

a. The emphasis was placed on implementing planning frameworks and strategies of growth boundaries, so as to control the rapid and high rate of urbanisation during the period 1970s–1986 (Al-Hathloul & Mughal, 2004).

b. Due to the natural boundary of the Arabian Gulf to the north and strict growth restrictions by ARAMCO towards the south, urban areas have massively expanded toward the east and west. Nevertheless, this period has also witnessed urban sprawl to the north, owing to land reclamation processes to the shallow tidal shelf to create the Corniche zone in the 1980s (Alabdullah, 1998).

c. As a result of this tremendous urban sprawl, the urban street has gradually become a "lost space", mainly owing to the increasingly dependence on the car. Almost the entire street space has been transformed to serve and facilitate car movement, whereas the dedicated space for pedestrians has been compressed.

d. Three major attributes characterising this period are the emergence of indoor shopping malls, seafront developments and the wide implementation of the concept of Transit-Oriented Development (TOD).

It is worth discussing the concept of TOD in more detail here, because this concept was found to be the most commonly cited standard associated with walking (Walker, 2012). But more importantly, it has become the most desirable pattern to be followed in developing Dammam as well as in other Saudi cities up to the present time. The TOD in Dammam is configured and oriented in different directions, and has never been assessed in relation to walking in the Saudi context. Accordingly, the author believes that the city is repeating the same mistake by mimicking new planning layout (i.e. TOD) without a careful attention to requirements of the local context.

The main feature of TOD is based on locating houses and services within a distance of 400m radius, which equals to ±10 minutes walking time, from the core area of a neighbourhood or to transit stops (Calthorpe, 1993). For Calthorpe, this distance represents a comfortable and convenient walking distance for most pedestrians, or how far pedestrians will be willing to walk (Walker, 2012). However, some sceptics suspect the 400m is comfortable only for a person of average fitness, particularly under severe climatic conditions such as high temperatures, humidity or torrential rain (O'Hare, 2006). Campbell and Cowan (2002), in addition, argue that "drawing a 400-metre walkband over an area does not make it work as a [walkable] neighbourhood or support mixed uses. In a city what matters is the total journey from origin to destination" (Campbell & Cowan, 2002: 41).

Similarly, drawing a circle with a radius of 400m over a randomly selected neighbourhood from the Dammam map did not reflect the actual walking distance as performed by pedestrians. This distance is intended for someone walking in a straight line, i.e. air distance, but on the ground pedestrians tend to choose the best route that suits their needs (e.g. safety, short-distance trip, pleasure and comfort). Hence, walking often takes a form of zigzag movements. In such a situation, which naturally occurs owing to the presence of buildings blocking the flow of straight movement, walking distance becomes longer, as illustrated in Figure 4.20. Additionally, almost all commercial activities and services in Dammam are not located in the centres of neighbourhoods. This contributes in creating a longer walking experience, which eventually becomes undesirable and even an exhausting activity in a back and forth travel between origin and destination.

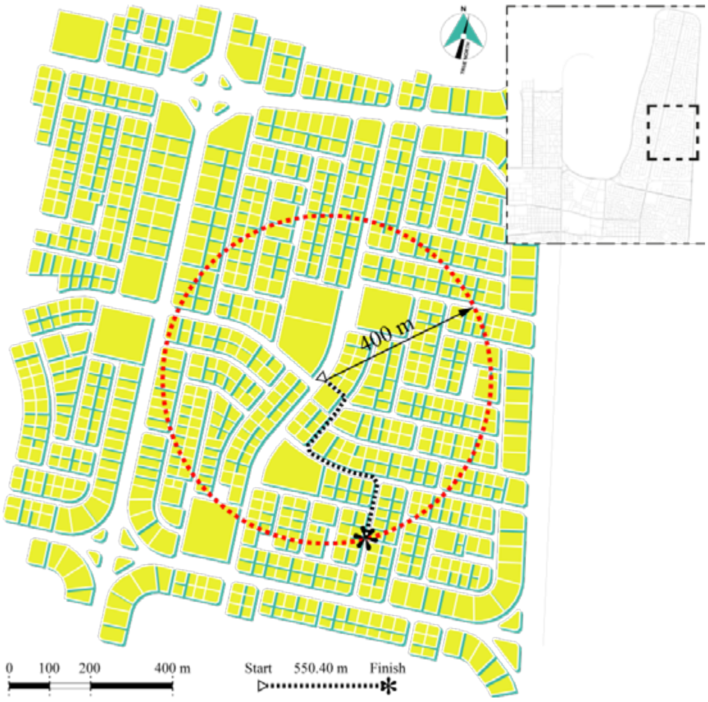


Figure 4.20 A randomly selected neighbourhood in Dammam to measure the 400m walking distance (Source: the author)

The point to be highlighted here is that the issue of walking distance is not a simple calculation applicable everywhere, but varies around the world. For example, people in most European countries tend to be comfortable with slightly longer distances than the 400m (Walker, 2012). Preference for walking is more complicated than a causal relationship with walking distance, and it is considered as a variable aspect. Thus, the 400m cannot be relied upon as a strong motive to encourage walking on Dammam streets, particularly when other influential factors affect pedestrians' willingness to walk, such as climate and environmental quality.

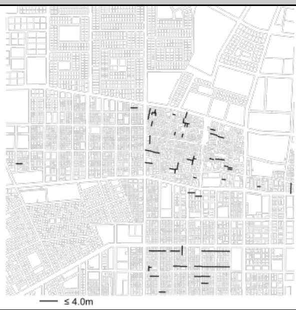
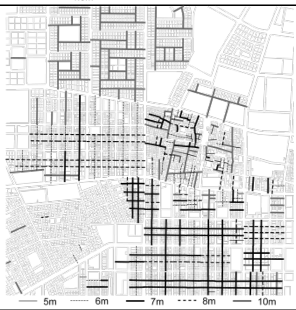
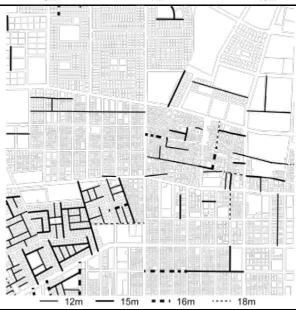
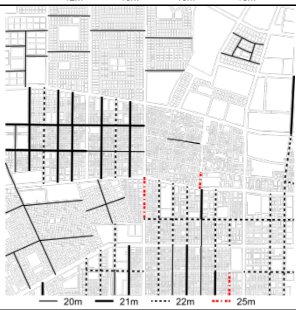
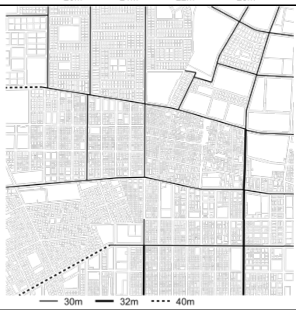
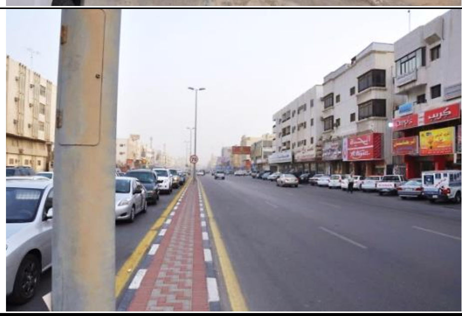
4.4.4.1 Typology and hierarchy of streets

By studying the hierarchy of streets in Dammam, it can be seen that the city comprises all the five categories of streets; from the motorway to the local access (Figure 4.21). Perhaps the most dominant type is the minor arterial, owing to the fact that almost all mixed uses, activities and services occur along this type of street. By analysing the street pattern–width relationship, street patterns can be grouped into five key types as illustrated in Table 4-2: (A) ≤ 4m; (B) 5-10m; (C) 12-18m; (D) 20-25m and (E) 30-40m.

During the ***early period*** of Dammam's formation, the streets did not exceed a maximum of 10m in width, and they are mostly included in types (A) and (B). Although both types have been preserved in the old fabric until today, streets of type (B), ranging from 6 to 8m were being constructed and continued in existence in the ***transitional period***, combined with the first emergence of wide to very wide streets included in types (D) and (E). During the ***period of massive urban sprawl*** or post-gridiron, types (C), (D) and (E) have been widely constructed, in addition to limited planning of 10m wide streets of type (B). This reflects the extent to which the city has been transformed from a pedestrian-friendly to car-oriented environment, where the car has become the shaper for the city design and the main transport mode.

Figure 4.21 Hierarchy of streets in Dammam (Source: the author)

Table 4-2 Typology of street patterns in Dammam (Source: the author)

Type	Pattern	Example
(A) V. Narrow Under 4m		
(B) Narrow 5 - 10m		
(C) Medium 12 - 18m		
(D) Wide 20 - 25m		
(E) V. Wide 30 - 40m		

4.4.5 Analysis of the physical and spatial characteristics of the existing street space

According to both the *Design Manual for Pavements* and *General Specifications for Constructing Urban Roads*, issued by the Ministry of Municipal and Rural Affairs (MOMRA) in 2006, the design of urban streets in the KSA has adopted the standards as those in the USA. These standards are defined by the American Association of State Highway and Transportation Officials (AASHTO) in the publication *A Policy on Geometric Design of Highways and Streets* (2001). However, on the first page of its Foreword, AASHTO states: “The intent of this policy is to provide guidance to the designer by referencing a recommended range of values for critical dimensions” (AASHTO, 2011: xli). It goes on to plainly point out the role of the local context in encouraging independent designs tailored to particular situations and settings. However, when considering using the AASHTO’s specified values for design criteria, it is worth keeping in mind two other statements from the same Foreword:

> “Minimum values are either given or implied by the lower value in a given range of values. The larger values within the ranges will normally be used where the social, economic, and environmental impacts are not critical” (ibid.).

With these fundamentals in mind, probably one of the factors with the most impact in analysing the existing street space for restoring walking is to examine the spatial distribution of pedestrian and vehicle zones within each type of the above street pattern. This includes the physical and spatial characteristics of the dedicated space for each type of users within each street type. For this purpose, the analysis presented in the subsequent paragraphs is based on the street patterns (Table 4-2) and data review of the *Design Manual for Pavements*, in addition to field measurements carried out by the author. This last activity was conducted by utilising a Digital Laser Distance Measuring Device (model BOSCH-PLR 50) (Figure 4.22).

Figure 4.22 The Digital Laser Meter employed during the field measurement

Typically, the space of urban streets can be divided into two zones: pedestrian zone (pavement) and vehicle zone (road), each of which has sub-zones with certain design considerations. While the vehicle zone is analysed in Table 4-4 and Figure 4.32 to Figure 4.35, and although it is very important in the discussion chapter, what matters most for detailed analysis in this chapter is the pedestrian zone. According to the *Design Manual for Pavements* (MOMRA, 2006: 4), design of the pavement zone depends on three major factors: (a) planning criteria, (b) volume of pedestrian traffic and (c) the nature of the adjacent land uses. However, any pavement space should generally comprise three major components: (a) right-side shy distance, (b) left-side shy distance and (c) effective walking space (Figure 4.23).

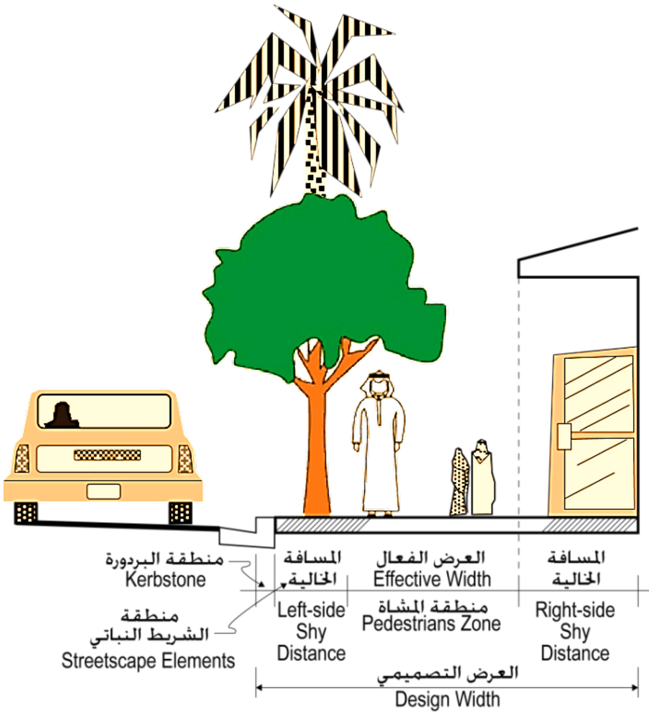


Figure 4.23 Spatial distribution or zoning of the pavement space in Saudi Arabia (Source: MOMRA, 2006: 3)

A. **The right-side shy distance** is that space of the pavement adjacent to buildings, fences and walls, which the pedestrians usually tend to avoid walking in (MOMRA, 2006). This space is typically dedicated for doorways, window shopping, utilities, private signs and displays and similar appurtenances. However, the width of this distance changes according to nature of the adjacent activities, land uses or fixed objects, as shown in Table 4-3.

Table 4-3 The relationship between the right-side shy distance and nature of selected adjacent fixed objects (Source: MOMRA, 2006: 3)

Nature of adjacent fixed objects	Shy distance width (m)
Fences and walls	0.5
Residential buildings	0.6
Commercial frontages	0.7
Frontages with display windows	1.0

B. **The left-side shy distance** is the space between the edge of the pavement and the effective walking zone that provides the minimum necessary separation between pedestrians and road surface. Therefore, it should be equipped with streetscape elements to enhance this separation. This, combined with the preference of the pedestrians to keep a distance from the traffic, means the minimum width of the zone is recommended to be 1.2m, which should be added to the minimum effective walking space (MOMRA, 2006: 5).

C. **The effective walking zone** is the clear space that pedestrians tend to keep between themselves and any fixed objects on the pavement, which might be capable of injuring them or causing discomfort walk. It is the throughway located between the inner edges of the two shy distances that must remain free of any obstacles; horizontally and vertically, including shops' awnings, carports and even landscaping. The width of the narrowest part of this space should be enough to accommodate two pedestrians conveniently, including those with special needs.

However, the existing conditions and uses of the pavements are not quite the same as designed. It is commonly observed that pavements suffer the consequences of encroachments by adjacent activities or behaviour of property owners, for example, the presence of doorsteps, street vendors, landscaping attempts and even the wrong placement of utilities boxes. Some of these drawbacks are illustrated in Figure 4.24. Such practices, usually work as obstacles, minimising the width of the effective walking zone. The pavement becomes inadequate for supporting convenient walking and smooth flow of the pedestrians. Eventually, the pedestrians often become compelled to walk in the vehicle zone (Figure 4.25) or completely withdraw from using the street for walking.

Figure 4.24 Some typical examples of encroachments on the pavement space (the author)

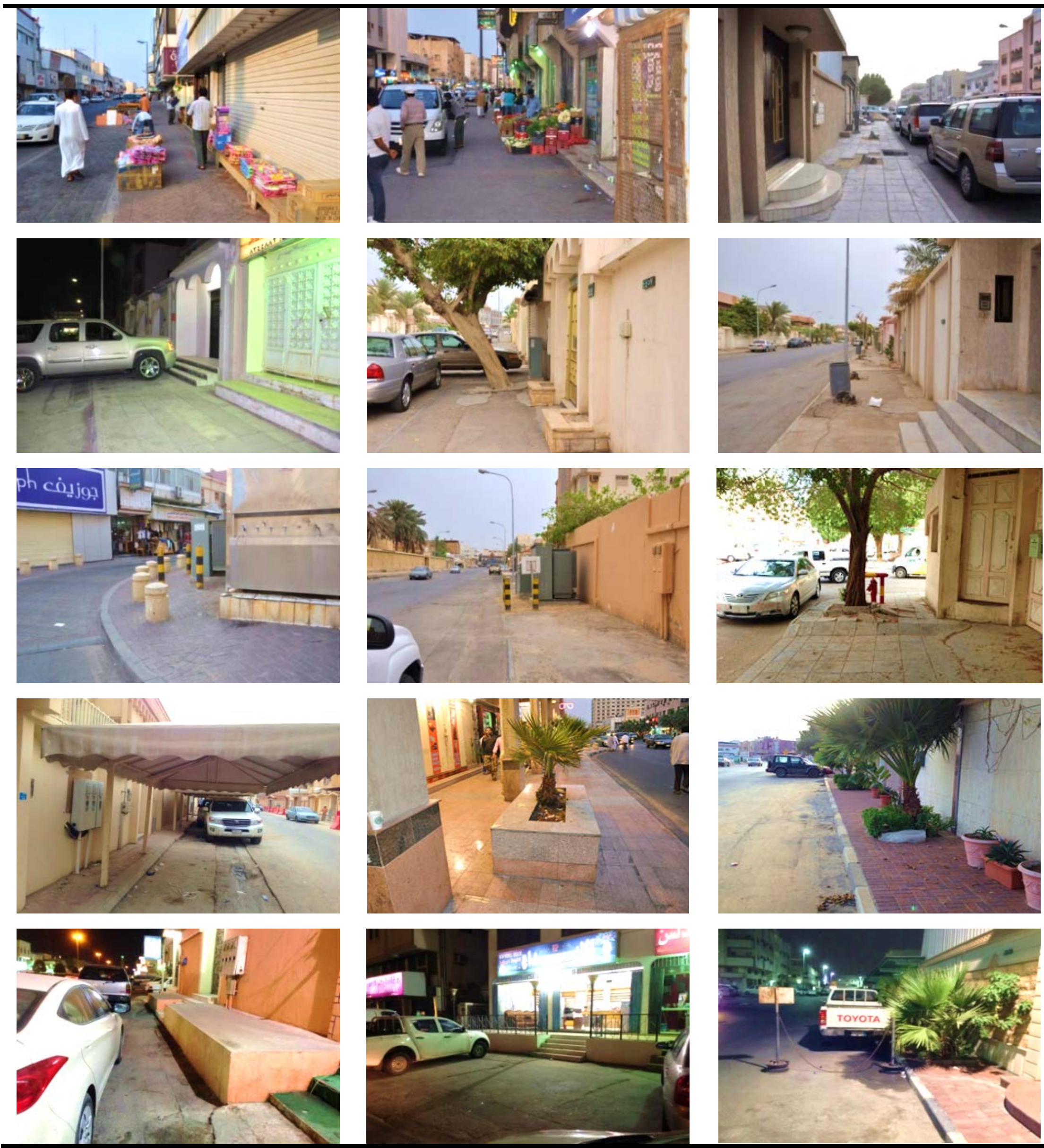


Figure 4.25 The lack of pavements, poor conditions of the existing ones or encroachments on their space very often force the pedestrians to walk onto the road surface (Source: the author)

Since 2009, driven by vast oil revenues in the previous years, MOMRA has supported carrying out a regeneration process for urban public spaces in major cities. Dammam Municipality, as one of the beneficiaries of this subsidisation, has initiated unprecedented massive urban regeneration projects, since the city was formed. Although the construction of walking tracks, and development of the existing Corniche walkways and neighbourhood parks have clearly received attention, main streets have received the largest share of attention and funding. However, local and collector streets have been confined to re-asphalting, while arterials have witnessed radical changes ranging from, for example, re-asphalting routes, replacement of standard lighting poles with decorative ones to the alteration of paving materials from the traditional cement tiles to interlock pavers.

Most importantly, the city has begun the establishment of automobile bridges and tunnels for the first time within its urban fabric, some of which are still under construction, whilst widening the existing vehicle zone. Typically, the space gained for this zone is for incorporating new traffic and parking lanes either at the expense of medians ‘central reservations’ (Figure 4.26/A), or at the expense of pavements (Figure 4.26/B). Such practices, in some circumstances, have produced pavements that do not exceed 40cm in width, or barely allow the passage of one person (Figure 4.27). In addition, a new approach was implemented through the conversion of two-way arterial streets into one-way routes when approaching the city centre area. Thus, it can be said that the main focus has been on solving traffic-related issues, while the pedestrians have received modest attention in a very limited number of streets of the city centre.

Figure 4.26 More spaces are typically gained for the vehicle zone at the expense of street medians and pavements (Source: A. Dammam Municipality, 2009; B. the author)

Figure 4.27 Widening the existing vehicle zone may produce narrow pavements inconvenient to accommodate two pedestrians simultaneously (Source: the author)

Regarding street medians, almost all arterials have recently witnessed the installation of a steel fence along this strip, which has previously experienced a narrowing process (Figure 4.28). Such an intervention has been accepted primarily for the sake of cars, but also has been proved an inappropriate physical component for pedestrians, and thus removed from many streets around the world. In practice, this element hinders one of the basic functions of street medians: as a refuge and transitional safe zone for pedestrians crossing streets, particularly, when the distance from kerb-to-kerb is wide.

Figure 4.28 Installation of the steel fence to the medians terminates the basic function of this strip as a transitional safe zone for pedestrian crossing (Source: the author)

The most important adverse effect of this solution lies in its impact on slow pedestrians, while crossing, such as the elderly, women with/out pushchairs and those with special needs. This is combined with insufficient pedestrian crossings or, if they are available, the distance between them is often designed so that they are several hundred metres apart. Moreover, the steel fence has become problematic leading to certain conflicts that compel the pedestrians to behave differently in pursuing what satisfies their needs (Figure 4.29). Although this very often puts them at risk, particularly women (Figure 4.30), it plainly demonstrates the consequences of neglecting the need to pay careful attention to understanding pedestrians' behaviour. Without being the determining factor, the steel fence may contribute, even if to a small fraction, towards uncomfortable and unsafe walking experiences. Consequently, it may discourage pedestrians, or even exacerbate their reluctance to make frequent use of the street space for walking.

Figure 4.29 The neglect of observing and understanding pedestrians' behaviour usually propels them to find alternative ways to satisfy their needs (Source: the author)

Figure 4.30 Installation of the steel fence into street medians completely hinders the most vulnerable pedestrians from safe and comfortable crossing (Source: the author)

It is interesting and thought-provoking that practices of street design in Saudi Arabia keep implementing, or rather imitating, some of the outdated applications that have already proved faulty in other contexts. It is time for such entrenched practices, which constantly prioritise cars over pedestrians, to be revised, so that the pedestrian zone should come first during any retrofitting process to urban streets, which would echo the "correct sequence" as put forward by Alexander et al. (1987). If this revision of priority was made, then designers would be in a better position to offer the appropriate intervention to restore the pedestrians into the street space.

The results of examining the spatial distribution of pedestrian and vehicle zones within each street type, through a data review of the *Design Manual for Pavements* (MOMRA, 2006) and the field measurements are summarised in Table 4-4. Subsequently, analysis of the physical characteristics of streets is presented in Figure 4.32 to Figure 4.35. Because type (A) occupied a very limited percentage of the total urban streets, together with the fact it has never been observed outside the early pattern of the city, it is eliminated from any further analysis. Generally, all streets comprise at least two traffic lanes, mostly one in each direction, separated by lane markings or planted medians within arterial streets. The width of this lane is relatively narrow on local and collector streets (types B & C), but wider on the higher volume streets (D & E).

Table 4-4 Spatial distribution of street space by street type (Source: the author)

Street Type		(A) V. Narrow	(B) Narrow	(C) Medium	(D) Wide	(E) V. Wide
Width range		≤ 4m	5 - 10m	12 - 18m	20 - 25m	30 - 40m
Pavement width	Minimum *	N/A	1 x 1.8m	2 x 1.8m	2 x 1.8m	2 x 1.8m
	Recommended with planting *	N/A	N/A	2 x ≥ 3m	2 x ≥ 3m	2 x ≥ 3.5-4.5m
	Actual measurement	N/A	2 x 0.50-1.0m	2 x 2.2m	2 x 2.8-3.2m	2 x 2.2-3.5m
Medians width	Standard *	N/A	N/A	N/A	N/A	3.4-4.5m
	Actual measurement		-	-	-	1.2-3.5m
Avg. No. of traffic lanes		N/A	2	2	2 or 3 in one direction	3-4 each direction
Avg. traffic lane width		N/A	3.6m	3.7m	3.8m	3.8m
Kerbside parking lane width	Standard *	N/A	1 x 2.4m parallel	2 x 2.4-2.7m parallel	2 x 2.5m parallel	2 x 2.5m (Parallel) OR 2 x 5m (Angle)
	Actual measurement	N/A	On-street	2 x 2.7m (parallel)	2 x 3-4m (parallel)	2 x 5.5-6m (Angle)

* *Source: MOMRA, 2006: 4 & 5*

The key finding that can be summarised from the table above is that urban streets, to a large extent, apply the highway standards; more priorities are given to the car and traffic at the expense of the pedestrians and pavements. When the vehicle zone, including traffic and parking lanes, is built too wide, pedestrians are often forced to walk further across streets on which cars are typically moving too fast (Figure 4.31). Additionally, regardless of street typology, the competition for space within this daily landscape is not fierce, where the vehicle zone is the winner every time, overwhelming and compressing the pedestrian zone. The presence of on-street parking, whether permitted or not, wide traffic lanes and narrow pavements are certainly the most prominent features.

Figure 4.31 Too wide vehicle zone certainly impedes pedestrians' crossing (Source: the author)

It is worth emphasising here that, according to AASHTO (2011: 7-29), a typical traffic lane width varies from 3.0-3.6m, although 3.6m is most desirable for major arterials with high speed and free-flowing traffic. With these criteria in mind, and referring back to Figure 4.21, the major arterial is a very limited street type in Dammam, thus traffic lanes ≥ 3.6m are most likely to become unnecessary. Supporting this claim, 3m traffic lane width is normally quite adequate for signalized streets at 70-80km/h (ibid.), which are exactly the existing conditions in all main streets in Dammam. In this context, Petritsch (2009) conducted a literature review on the influence of traffic lane width on *safety* and *road capacity*, these being the most often cited issues related to narrowing traffic lanes and concluded that such issues are not adversely impacted by narrowing the lane width to 3m.

Moreover, according to AASHTO (2011: 4-73), the standard width of parking lanes ranges between 3.0 to 3.6m. This width is considered enough to provide better clearance and to accommodate potential use of the parking lane for through traffic, public transport and a variety of land uses. However, reducing width of this space to 2.4m remains quite adequate (ibid.) in all street types[36] (except arterials), even parking space as narrow as 2.1m may be acceptable (ibid: 7-34). For signalized arterial streets, a parking lane of 3m wide should be maintained only if it can be used as a storage lane for turning vehicles or for occasional use by medium sized commercial trucks. However, a parking lane narrower than 3.3m is considered

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[36] On the average, most vehicles occupy approximately 2.1m of actual street width and park parallel at a distance of 15-30cm from the kerb face, thus the desirable minimum width of a parking lane is 2.4m.

undesirable if future use of this lane (or during peak hours) for through traffic is anticipated (ibid: 7-34). Based on this last exception for arterials, which has not been observed to be applied anywhere in the Dammam context, it is unjustified to dedicate a parking lane wider than 3m. In Dammam, arterials are typically constructed with angled parking of 5.5m in width, on average, although the MOMRA regulations require only 5m for angled parking or 2.5m for parallel parking.

Given the information discussed above, it is very easy to rebut any argument against narrowing lane widths in the vehicle zone. Accordingly, a lane width of 3m for both the traffic and parking should be considered most desirable within urban streets, if accommodating pedestrians are significant social, environmental, economic and health issues. An analysis of the physical characteristics of street space is presented in the following paragraphs and illustrations.

One of the primary features that can be clearly identified is the significant similarity in the physical characteristics between all street types. This means, regardless of street width, it is very rare to find any noticeable differences or major components directed to the pedestrians among Dammam’s streets. The pedestrian zone is always surrounded by property walls on one side and asphalt road on the other. Not only that, but these streets evidently lack the basic streetscape elements such as seating, planting, pedestrian-scale lighting, shading devices and even the right selection and diversity of construction materials and colours which could enhance the visual quality and eventually the walking experience. Figure 4.32 shows an example of pattern of street type (B), which lacks appropriate pavements, and hence street furniture. Therefore, the pedestrians find themselves forced to walk onto the road.

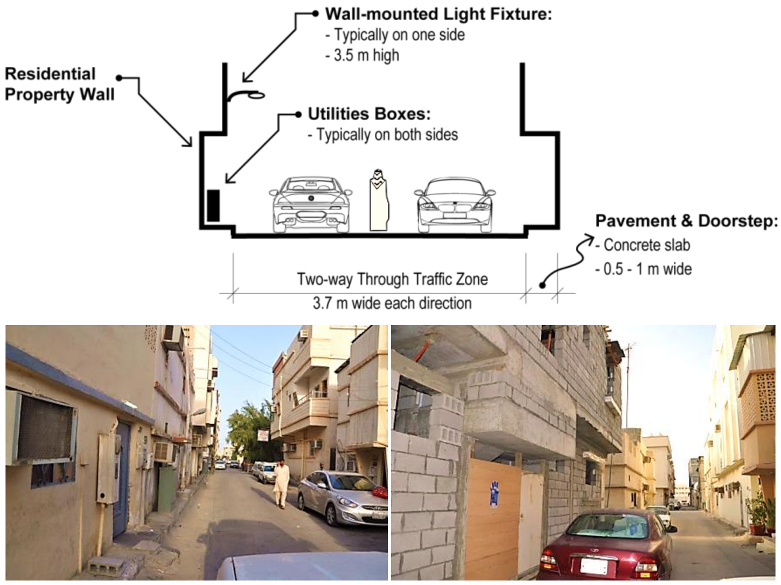

Figure 4.32 Typical section and images for street type (B) showing the anatomy of the main physical elements within this street pattern (Source: the author)

Although Figure 4.33 below shows that a typical model of street type (D) is constructed with pavements 2.8m wide, the pavement shown is suffering from several physical obstacles hindering its use for walking, and propelling the pedestrians onto the road. It also reveals the discretionary practices of pavement design, whether by residents or municipality, through; for example, the wrong selection of planting materials, which, if available, has gradually led to their removal from streets by the municipality or their falling.

Planting in the middle of pavements, if it exists, is typically in pits $1m^2$, hence narrowing the effective width for walking. Most planted pavements along this type of street are those constructed during the transitional period, whereas most streets built during the urban sprawl period were designed without taking urban trees into account. However, the process of incorporating trees into streets reached its peak between 1975 and the mid-1990s. Pavements along this type of street are typically paved with traditional concrete tiles sized 45x45cm, or, in some cases, with asphalt. Due to lack of any shading techniques, the space is always exposed to solar radiation.

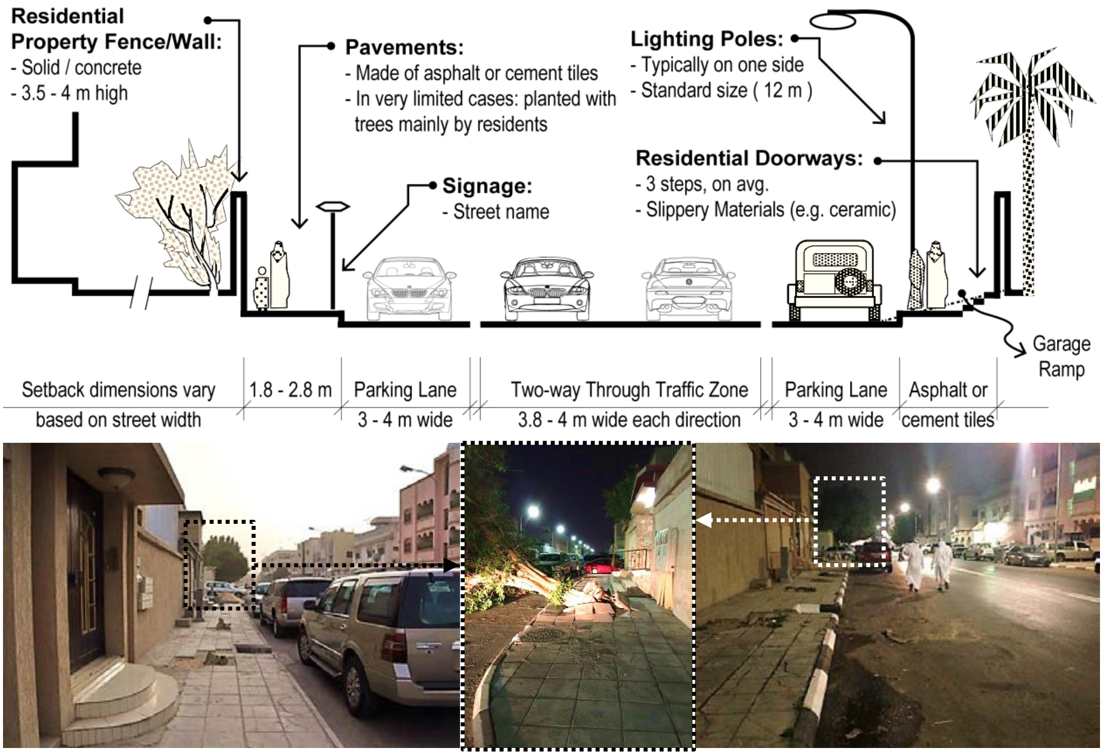

Figure 4.33 Typical section and images for street type (D) showing the anatomy of the main physical elements within this street pattern, and implications of the wrong selection of planting materials (Source: the author)

Figure 4.34 shows a typical pattern of street type (E) and repeats the same street image found in the previous types with minor variations, which are the presence of street medians and different paving material. This pattern is always a mixed-use street between residential and commercial activities. Streets usually vary in width from 30 to 40m, and are typically surrounding neighbourhoods from the four directions. Municipal regulations permit buildings of over three-storeys along this type of street, which results in commercial activities on the ground floor level and residential uses on the upper floors. Without being the determining factor, such a physical aspect may contribute in reducing wind velocity for the low height residential dwellings (up to three floors high) that lie behind these tall buildings.

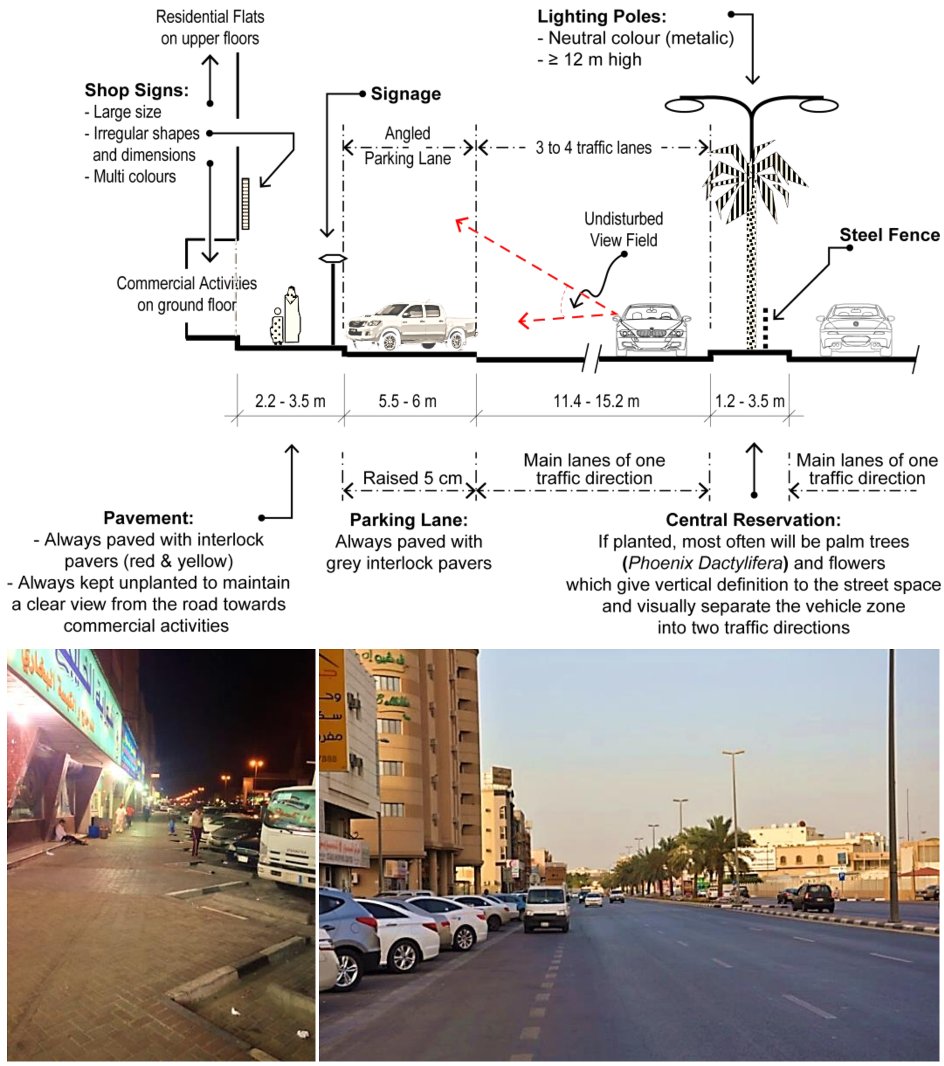

Figure 4.34 Typical section and images for street type (E) showing the anatomy of the main physical elements within this street pattern (Source: the author)

Planting in street medians is mostly carried out in continuous pits, like ditches. Among the plant species, palm trees (*Phoenix Dactylifera*) are the most popular in this pattern of streets and planted aligned about 5 to 6m apart. Obviously, it became a tradition in the city to plant palm trees whenever practical, however, in limited cases, other tree species were found to be planted along this area as well. Ground cover and seasonal flowers are planted between the palm trees.

There are some advantages of planting palm trees along medians. Because the main function of medians is to separate the two opposite traffic directions, combined with the growth shape of palm trees, palm trees are used as a large-scale vertical dimension so as to create physical and visual barriers, in addition to adding aesthetic landscape design values to the street space. Pavements along this type of street were supposed to be planted with trees but these also underwent a removal process. This may be attributed to the adjacent commercial activities where trees usually block the motorists' view.

Figure 4.35 shows the best available example of streets in Dammam, in terms of some efforts having been made towards the needs of pedestrians. King Saud St. is a minor arterial road, with E-W orientation, located in the city centre and bordering the old fabric from the south. This street has received special attention at four levels: (a) widening the pavement space, (b) incorporating streetscape elements, (c) adopting traditional building style to restore the city identity, including cladding old buildings with false fronts and (d) conversion of the vehicle zone into a one-way route, and hence obtaining additional traffic and parking lanes.

Pavement width located on the southern side of the street is clearly wider than the one located to the north. Although this may seem rational and practical to get the optimum benefit of shading from adjacent tall buildings, which are quite often taller than those on the northern side, it is unfair for pedestrians and stalls for commercial activities to the north of the street, which are exposed to the longest period of solar radiation.

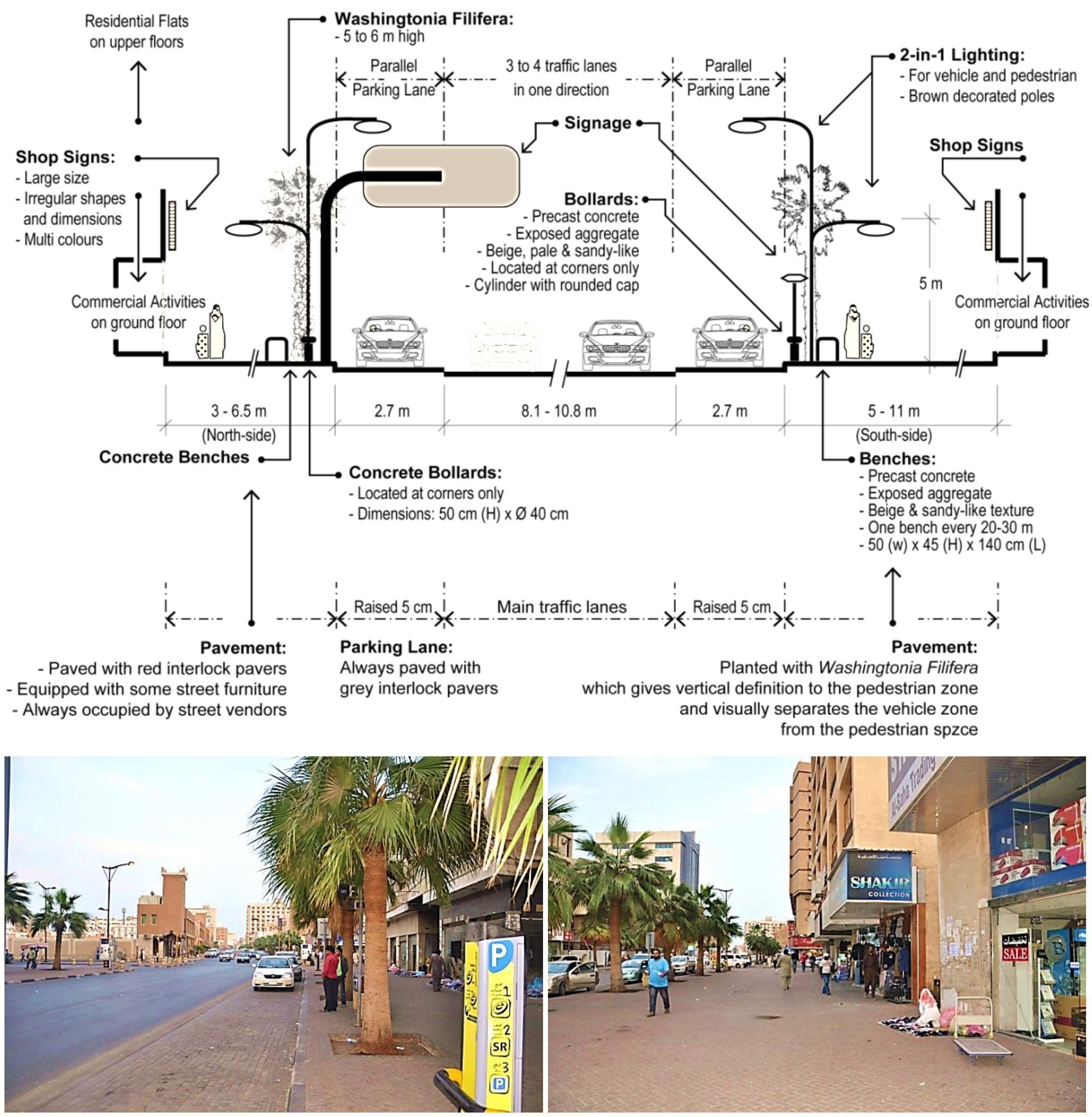

Figure 4.35 Part of King Saud St. located in the city centre is the most distinct available example that has received special attention towards the needs of pedestrians (Source: the author)

However, the streetscape elements have major drawbacks in terms of material selection, including thermal properties, design and colour, in addition to improper selection of planting material. Firstly, the extensive use of concrete is considered inappropriate due to its thermal properties that absorb heat during the daytime and dissipate it after sunset, which is the peak time for pedestrians on streets. Such a property, on hot and humid days, often causes wet spots underneath seated users, due to sweating of the body in a natural response to the dissipated heat from the concrete. This side effect of the concrete typically hinders men wearing light colours from using the installed benches.

Secondly, bearing in mind the national costume for both genders (i.e. black for women and white for men), the texture of the concrete benches and bollards always captures dust, thus they become quite unsuitable and discouraging for sitting. Thirdly, the primary function of the bollards is seemingly to prevent cars from going up onto the pavement, neglecting their potentiality to be used for sitting, which is actually happening. However, the rounded-shape cap of the bollards makes sitting uncomfortable. Fourthly, the use of *Washingtonia Filifera*, although it is an exotic palm tree, consumes a lot of water, and neither helps to restore the local identity to the street space nor provides necessary shade to the wide pavement.

Regarding the last point, probably one of the most challenging issues facing the practice of landscape architecture in the KSA is urban greening, thus, the following section completes this chapter by focusing on the most pertinent issues to this area.

4.4.6 Water resources and street trees

One of the most frequently cited factors associated with fostering walking is street trees, whether for providing a thermally acceptable environment or for enhancing the overall quality of the street space. But, for Dammam, which lacks any rivers or freshwater lakes, together with very little annual rainfall, the shortage of water has always been believed to be the most influential factor behind the failure to establish urban greening on a wide scale of the city (Al-Awais, 1991). These factors, combined with the massive urban growth, mean the demand for water is increasing, and thus freshwater is extremely valuable. However, the following paragraphs demonstrate the potentiality of the city to become green, without the use of the available resources. Accordingly, it would be more rational to review this issue in terms of identifying the water resources and hence water supply for irrigation.

Dammam depends on two water resources: aquifers and seawater. Until recent years, the aquifers were a major source of water and constitute vast underground reservoirs. Therefore, the government made a major effort in 1970s to map such aquifers. Since then, tens of deep tube wells were drilled in and around the city (Bin Marshad, 2014). However, according to the National Geographic (2013), based on the extraction rates, it was estimated that the Kingdom would have already consumed about 4/5 of its groundwater by 2008. In anticipation of such a consequence, the city had already turned to the process of desalination of seawater to producing enough water to support its development. This innovative technique has become the main source to provide more than 70% of the water used in the city (Bin Marshad, 2014).

However, an expanded and promising source of water is the use of recycled wastewater. To this end, water treatment plants are expected to recycle over 40% of the used water (ibid.). To verify this information, the author conducted an interview with the environmental engineering manager at the General Directorate of Water Eastern Province (GDWEP) on 5th August 2012. The manager clarified that the treatment stations in Dammam received about 410,000 m^3/day of wastewater which was being treated by bilateral and tripartite treatments. As a result, about 210,000 m^3 (51%) of treated wastewater is generated every day. The quality of the recycled water is suitable not only for irrigating street trees but also for direct human use (e.g. edible products, toilets); the salinity of the treated wastewater ranges between 1200 to 1800ppm.

This large volume of treated water was always dumped to the sea, until the GDWEP started, in June 2012, the construction of a pipeline project, with the aim to convey this water south to Al-Ahsa city for agriculture. Therefore, the recycled water from Dammam plus another 210,000 m^3/day from the treatment plants in Khobar city will be pumped to the Al-Ahsa oasis, instead of using it for urban irrigation. Perhaps what is surprising is that urban greening, where it is present, such as the green areas along the Corniche of both cities, is being irrigated by the desalinated water, while the treated wastewater is a reliable source for urban irrigation.

Theoretically, the produced quantity of treated water would be enough to irrigate 420,000 street trees per day in winter, or 262,500 trees daily in summer. These estimates are based on using *Albizia Lebbeck* or *Delonix Regia* at mature size (3m high) at an average daily consumption of 5 litres/day/tree in winter, and 8 litres/day/tree in summer, due to the potential evaporation rate (Rick, 1992). These examples of trees, among other exotic trees proved to grow successfully in the Kingdom, have been approved by the Municipality of Dammam as suitable species for urban use, due to their efficiency for shading, drought resistance and salinity tolerance.

4.5 Summary

The rapid pace of the transformation processes of Dammam's streets, from the traditional narrow and irregular pattern into the western wide and straight model, was mainly due to the great attention that the gridiron layout and the car have equally received. Both these components were considered inevitable alternatives to the traditional, compact built environment that was perceived as an obstacle in the way of modernity. The grid plan combined with the new standardised street characteristics, building codes, zoning and land subdivision regulations have been followed irrespective of any local environmental qualities. The advent of the car was seen as a major source of conflict and threat to continuity of the traditional city pattern, and thus took the largest share of attention and priority in street design.

The connection with everyday activities in the street was lost in favour of more mobility and opportunities for engagement without the locality. This led to an early transition towards disjuncture with the notion of locality and social coherence. Accordingly, the street space has lost its vibrancy and dynamism, and has even been compressed and degraded as the daily pedestrian landscape; thus, pedestrian-oriented facilities only fulfilled the most basic standards. Clearly, women are the group most affected by the deficiency of the street space to support walking.

Climatically, owing to the location of Dammam, the level of humidity is most often intense. The city experiences high air temperatures during the summer months, and hence Dammam often becomes extremely hot under direct solar radiation, where the summer is the season that brings most discomfort for pedestrians without protection measures. In the light of the above two factors, wind velocity becomes a much more important factor to mitigate such a severe climate, particularly when the street's geometry is not compatible with the prevailing wind direction. Owing to the sun path and wind direction to which Dammam are exposed, it is impractical and irrational that streets with N-S orientation should be designed in a similar way to streets with E-W orientation, in terms of depth of street canyon and width of pavements on both sides of the street.

Although the theory of proxemics may seem irrelevant to some contexts, the actual reality revealed that the personal space remains a very significant aspect for the

Saudi society. Proximity, which largely governs the interpersonal interactions particularly between the opposite genders, has been proved to be a very sensitive quality with regards to the use of outdoor spaces in the KSA. However, the role of personal space, either in the street context or between the pedestrians, has never been studied, although it may have an explanatory power to account for the pedestrians' reluctance to use the street space for walking. Therefore, it would be more pragmatic to measure the level of such an impact from the perspective of the actual pedestrians.

By analysing the physical and spatial characteristics of street types in Dammam, several problems concerning pedestrians were identified which may contribute to a walking experience that is visually unattractive, thermally uncomfortable and physically stressful. One of the key findings of this chapter is the lack of pedestrian-oriented streetscape practices, including landscaping, in the street design. Firstly, the vehicle zone is excessively wide, mostly at the expense of the pedestrian zone. Street spaces are almost identical and hence have created a monotonous street environment.

Secondly, practices of street design towards pedestrians were confined to incorporating pavements, which, seemingly, are neither wide-enough to accommodate convenient walking nor well-equipped to facilitate a smooth progress. The quality of the paving material is very poor: pavements are either covered with asphalt or cement tiles, both of which are well-known to have low albedo values and visual quality. Thirdly, urban greening is exercised mostly along street medians and, in limited cases, on pavements of main streets, whereas pavements of other street types have been left to the discretion of residents. Such practices often lead to the wrong selection of planting materials, which has eventually led to their removal from streets creating bare and discouraging pavement space for walking.

Following what has been achieved in the previous three chapters together with the further reviews conducted in this chapter and the factual materials pertinent to Dammam's context, the next chapter will present the data collection methods adopted for the fieldwork. This is in order to investigate the research question in regard to the proposed conceptual framework, by detailing how this process was carried out, including any challenges of researching the actual pedestrians in the actual walking environments in Dammam.

Chapter Five: Methodology

"If 'methods' are technical rules that define proper procedures, 'methodology' is the broad theoretical and philosophical framework into which these procedural rules fit. [...] method and methodology cannot be separated [...] Because method and methodology are so intertwined" (Brewer, 2000: 2-7)

5.1 Overview

After briefly introducing the overall methodology of the study in Chapter One (section 1.10), this chapter presents the methods adopted for the data collection process. This includes describing why these particular methods were employed and how they were implemented *in situ*. It also outlines any organisational issues, procedures and challenges that this process encountered.

Additionally, the chapter delineates the rationales behind adopting the 'case study' method, explains the adopted techniques of the 'mixed methods' data collection approach and discusses criteria for site selection. In providing descriptions and a full picture of what the researcher was doing, observing, feeling and experiencing, so the account of the research becomes "vivid, compelling, and persuasive to a reader that the researcher has "been there"" (Miles et al., 2014: 185).

5.2 Introduction

The focus of attention of this research on pedestrians' experience of walking on streets, for any purposes and particularly as a lifestyle, is an unprecedented research project for the Saudi context. Specifically, the available information on pedestrians, walking and urban streets is very limited, while other necessary data has never been made available (see section 1.6).

These deficiencies not only justified conducting this research in the first place, but also emphasised the need to seek for an innovative methodological strategy for collecting the data required to respond to the research objectives. Although theoretical studies were important for developing the scientific background about the phenomenon under study, a purely theoretical approach was surely deficient to answer the research question, which seeks to find reasons for pedestrians' withdrawal from the street space to other urban places.

Accordingly, one of the most important gains in doing this research is to collect, compile and disseminate a realistic and updated picture of the demographic information regarding pedestrians in the KSA. However, it may be helpful to restate here that the key role of this research was to explore the cause-and-effect relationship between street design and walking. This was approached through examining the pedestrians in their actual walking places, by means of:

a) Interviewing them directly in all available walking places, in Dammam; and

b) Observing their actual walking patterns and behaviour within the street space only.

5.3 The selection of the case study as the overall methodology

Proceeding from the firm belief of this thesis that changes in the current lifestyle of the pedestrians (i.e. walking in other urban places rather than streets) cannot be imposed, but are not difficult to attain[37], finding out how to restore them into the street space was better to be answered from the pedestrians themselves. Similarly, Canter (1977: 1) asserts that "If we are to understand people's responses to places and their actions within them, it is necessary to understand what (and how) they think". Jacobs (1961: 238) further emphasises that "Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody".

Thus, the researcher's personal experience, as an academic in Landscape Architecture, coupled with a careful consideration of the data collection procedures of relatively closely-related studies[38], and the nature of the research problem and question, all supported the ***case study*** approach as the most appropriate method of research carried out in a ***field study***, particularly when little data exists or there is a lack of precedent studies (Liu, 2007).

[37] The study postulates the potentiality to achieve this change by reclaiming the street space in a responsive way that provides thermal comfort to the pedestrians and compatible to their socio-cultural requirements.

[38] BaHammam (1995, 2003, 2004 & 2009); Al-Abdullah (1998); Alznafer (2014).

Adopting this method is typically preferred "when (1) the main research questions are "how" or "why" questions; (2) a researcher has little or no control over behavioural events; and (3) the focus of study is a contemporary (as opposed to entirely historical) phenomenon" (Yin, 2014: 2). This research encompasses all these three criteria, and hence the selection of the case study method was highly relevant and justified. Although Yin argues there is a slight difference between 'case study' and 'field study' research, he himself states, in his technical definition, that the case study method is "an empirical inquiry that investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not clearly evident" (Yin, 2014: 16).

Within this framework, the 'field study' was a practical approach which enabled the researcher to gather the data relevant to the actual problem directly from the actual pedestrians. Hence, the value of using a field study was that:

> "Unlike controlled studies, such as experiments, field studies avoid pre-judgment of the nature of the problem and hence the use of rigid data-gathering devices and hypotheses [...] Rather, their mission is typically the discovery of new propositions that must be tested more rigorously in subsequent research specially designed for this purpose" (Shaffir & Stebbins, 1991: 18).

Another justification for following this overall approach lies in its emphasis on daily events and practices, as occurring naturally within their actual context or 'natural setting'[39], and hence provides a realistic diagnosis (Miles et al., 2014). It also serves as an 'ideal laboratory', in which landscape architects can gather first-hand evidence on actual use of outdoor spaces and the users' behaviour (Al-Abdullah, 1998). Molnar (2015) further points out that findings which emerge from evaluating the actual users in their natural setting are very significant to:

> "provide evidence of what worked and what didn't. And such evaluation, go a long way toward pinpointing where adjustments are deserved or preventing the duplication of mistakes in the next job" (Molnar, 2015: 25).

[39] See section 5.7.1 for definition.

5.4 The selection of the mixed methods as the data collection approach

The ‘case study’ method may depend on qualitative, quantitative approaches or both (Stake, 1995; Woodside, 2010; Yin, 2014), and is thus dubbed as “mixed methods” (Creswell, 2015). Each approach can provide exploratory and explanatory data, but adopting the proper one, which serves best in any particular research, varies from one study to another, depending on several criteria (Yin, 2014).

Although the final results of the present study may become of an explanatory nature, to account for the pedestrians’ withdrawal from using the street space for walking, this research is initially of a high exploratory nature, owing to: (a) the unprecedented nature of the research problem and question in the Saudi context; (b) the nature of the proposed conceptual model, which is largely interconnected with pedestrians’ judgement; (c) the lack of control by the researcher over the behaviour (walking) to be investigated and the actual urban spaces hosting this activity, and (d) the nature of the anticipated results and implementations.

At first glance, such an exploratory nature may call for purely adopting a qualitative research method, to attain a deeper understanding of the relationships between a phenomenon and the context encompassing this phenomenon. Merriam (2002: 5) emphasises that usually “researchers undertake a qualitative study because there is a lack of theory or an existing theory fails to adequately explain a phenomenon”, and hence usually involves a field study, through which intuitive understandings are gained (Merriam, 1998).

Thus, researchers involved in a field study “regularly use qualitative methods to address questions about people’s ways of organizing, relating to, and interacting with the world” (Guest et al., 2013: 1). This “means that whatever instrument used in collecting qualitative data, it is secondary to the researcher’s perception” (Mligo, 2013: 44) where “the researcher is the primary instrument for data collection and analysis” (Merriam, 2002: 5). However, such a research type is less robust in the context of the present study compared to the mixed-method.

Because there are strengths and weaknesses to any single data collection strategy, using more than one approach permits the researcher to combine strengths and correct some of the deficiencies of any one source of data (Patton, 1987). Specifically, the mixed-method approach has been favoured “as the best strategy for discovery, for exploring a new area [particularly] when one needs to supplement, validate, or illuminate quantitative data gathered from the same setting” (Miles et al., 2014: 12). In fact, the ‘case study’ research recommends avoiding:

> “a single source of evidence [...] most of the better case studies rely on a variety of sources [...] All sources of evidence were reviewed and analyzed together, so that the case study’s findings were based on the convergence of information from different sources, not quantitative or qualitative data alone” (Yin, 2014: 114).

Although the mixed methods study can be either used as a methodology or method (Creswell, 2015), it was employed in the present study as a method for data collection, combining quantitative and qualitative techniques for both numeric and narrative analyses.

5.4.1 Justifying the selection of the mixed methods

Several authors stress how adopting the mixed methods approach in case study research can yield appreciable benefits above those from either form of data alone (e.g. Stake, 1995; Yin, 2014; Olafson et al., 2015). It also enables the researcher to obtain rich insights and deep understanding into what was happening, and why it was happening in the way in which it occurred, particularly in a field study. Even more importantly,

> “The use of mixed or multiple methods in case study research usually contributes to increasing accuracy and complexity/coverage in a study, more so than generality. A mixed-method approach is likely to provide confirmation and disconfirmation of some beliefs and feelings of participants collected during [for example] interviews by examining data collected using alternative methods within the same context” (Woodside, 2010: 33).

Employing the mixed methods, as a strategy for the data collection and analysis processes, was logical in this thesis, because the factors affecting an individual’s choice to walk are of a multifaceted nature. Hence, any single technique may respond to a part of the research objectives but would not be enough to cover the major dimensions associated with the pedestrians’ reluctance to use urban streets for walking. Accordingly, five specific reasons influenced the decision to use mixed data collection techniques:

a) The sensitive socio-cultural aspects of Saudi society: namely, male-female interview restrictions, including female privacy, and the possibility that pedestrians may not be literate required multiple techniques and skills to gather data;

b) To allow the researcher to combine strengths and correct some of the deficiencies of any one source of data, and hence providing mutually supportive data from the study of the actual walking environments and from the actual pedestrians;

c) The actual walking places may encompass many variables beyond the phenomenon under study per se: thus, understanding this issue through multiple sources of evidence provides a profound picture of all possible factors pertinent to the decline of walking rates on streets, as experienced by the actual pedestrians. Because "both inductive and deductive reasoning [can be extracted from] mixed method research, the results are far more robust, especially in case study research" (Kitchenham, 2010: 563);

d) As one of the potential factors which may contribute to gaining deep insights into understanding how pedestrians can be restored into the street space, assessing the relevance of the personal space to the pedestrians is highly recommended to be measured both quantitatively and qualitatively (Al-Abdullah, 1998). By asking the pedestrians directly (in the available walking places) and also observing them in the selected streets, the accuracy of the final findings can be increased compared with that when relying on a single technique; and

e) Identifying from different angles whether the reluctance of pedestrians to use streets for walking is based mainly on socio-cultural factors, environmental factors, street design or all of these, from different angles, would be more pragmatic.

5.5 Introducing the techniques

The main research question of *how the neglected street space can be reclaimed to restore walking under hot-humid climatic conditions with certain outdoor socio-cultural requirements* has implications, not only in terms of the choice and implementation of the proposed conceptual model, but also for the selection of the most appropriate data collection techniques.

Drawing on nature of this question, and hence the main aim to be achieved, it was fundamental to get involved in direct contact with the actual pedestrians in their actual walking places. Without this strategy, it would be much harder to test the proposed conceptual model, and hence it would become difficult to understand the real challenges in finding the reasons behind the pedestrians' withdrawal from using urban streets for walking.

In this regard, Peil et al. (1982) suggest that carrying out a research project in developing countries, particularly where few similar studies have been already conducted, requires researchers to create their own strategic approach for data collection. They emphasise that people with "no experience of being interviewed, often need a different approach than urban European who are acquainted with interviewing from radio and television if not from personal experience" (Peil et al., 1982: vi).

In order to answer the above question and acquire the necessary knowledge of the research problem, two data collection techniques, commonly used in mixed methods research, were chosen. The strategy of combining **interview-based questionnaire** with **participant observation** was conducted in a field study, to provide a fuller picture of the situation under study (Barrett & Finch, 2014). Moreover, both approaches are more humanistic, since they acknowledge the differences among people and restore the complexity of human subjects to the research agenda (Sommer & Sommer, 2002; Spradley, 2016).

The interview-based questionnaire was the major data collection technique to answer the main research question, while the observation was as a supporting method for comparisons, to ensure the validity of major findings of the questionnaire. This was due to the fact that studying one component (outdoor thermal comfort) of the proposed conceptual model necessitated subjective evaluation, which cannot be obtained by observation. This means that the answer to the main research question will be mainly subjective (i.e. from the pedestrians' standpoint) but obtained by relying heavily on objective analysis of the questionnaire.

Accordingly, the interview-based questionnaire was carried out first, to enable the researcher to collect data that would help him to better understand the weight of the three components of this model, collectively, on the pedestrians' withdrawal from the street space. Certain aspects were identified to be the focus of the questionnaire, while others were left for the participant observation.

5.6 Structured interviews with standard questionnaires

Of all methods of data collection used by social sciences, the interview-based questionnaire is the best known and most popular; millions of interviews are conducted yearly in order to obtain data about attitudes, opinions and behaviour of individuals or groups (Bernard, 2006; Neuman, 2014; Brinkmann & Kvale, 2015; Bryman, 2016). However, the term is composed of two parts; questionnaire and interview, and hence a distinction between the two is essential.

The questionnaire, as a quantitative technique, aims to collect numerical data for statistical analysis (Foddy, 2001). Its use is primarily to discover regularities among groups of participants by comparing answers to the same set of questions (Zeisel, 2006). Interviews, on the other hand, as one of the most common qualitative techniques, focus on obtaining in-depth descriptive information behind participants' experiences, views and attitudes of a particular issue (Creswell, 2014; Neuman, 2014; Brinkmann & Kvale, 2015; Bryman, 2016). Additionally, they have proved useful to study socio-cultural phenomena and behaviour by "unpacking the black box and getting at the Why?" (Carter (1994), as cited in Boodhoo & Purmessur, 2009: 6).

However, the style adopted in this thesis was neither fully quantitative nor qualitative by definition; rather, it was located in the middle, between structured interviews and questionnaires. Although researchers use different terminologies for this, the main purpose remains the same, where the researcher and participants are in the same location at the same time. For example, it may be referred to as a "face-to-face survey questionnaire” (e.g. Chilisa & Preece, 2005; Gillham, 2007); “face-to-face interviews” (Neuman, 2014); “interview questionnaire survey” (Hsia et al., 2010); “a researcher administered questionnaire” (Bernard, 2006; Neuman, 2014); “questionnaire guided interview in field survey” (Nikolopoulou & Lykoudis, 2007); “structured interviews with standard questionnaires” (Nikolopoulou & Lykoudis, 2006); or “questionnaire-guided interviews” (Nikolopoulou et al., 2011).

Such an approach has been applied and tested in relatively similar studies, and was acknowledged to be most desirable and reliable to ensure a successful gathering of the required data, particularly for the responses related to pedestrians’ thermal comfort (e.g. Nikolopoulou & Lykoudis, 2006, 2007; Alznafer, 2014), and those related to socio-cultural attributes of pedestrians (e.g. Tsao, 2007; Hsia et al., 2010). However, during the actual field study, the researcher, in many cases, was asking the questions and filling in the participants’ responses. This was attributed to: (a) the fact that the participants’ hands were sweating as a result of walking activity; or (b) some participants preferred the interview-like situation.

5.6.1 Justifying the selection of the interview-based questionnaire

Due to the overall nature of the study, which sought the pedestrians’ justification of their reluctance to use the street space for walking, this strategic approach was inevitable for collecting the necessary data. This method was considered much richer in content, as it can yield more noteworthy and unusual results than the conventional written questionnaire alone (Foddy, 2001; Neuman, 2014). Moreover, it is a significant issue to explain why other questionnaire instruments have not been adopted; the reasons are as follows:

a) There was no database differentiating between those who do or do not walks nor between those who use streets or other places, and hence it was impossible to adopt alternative techniques to the face-to-face situation;
b) The use of other types of questionnaire, outside the actual walking places, often lacks visual support and reference to geographical location, and hence makes it difficult to link answers to physical characteristics of these places;
c) When conducting surveys through mail questionnaires, for example, the researcher cannot ensure people will respond, particularly as the Saudi society is

not accustomed to such a form of communication, and this also holds true for telephone questionnaires;

d) The open nature of the selected walking places lacks controllable boundaries, and thus makes it hard to obtain the required number of samples in any way (such as drop-and-collect) other than using a face-to-face situation;
e) Any other types of questionnaire may neglect and lack documentation of important expressions, thoughts, clarifications and interpretations; and
f) While the conventional paper-based questionnaire is often in need of interpretation, the face-to-face approach is interactive and dynamic, and thus may become self-interpreting.

On the other hand, several positive factors influenced the decision to adopt the interview approach for implementing the questionnaire; these are as follows:

a) The face-to-face situation has been found to be effective to ensure gathering a sufficient quantity of data and samples from outdoor pedestrians in the KSA (Alznafer, 2014), otherwise participants could not be reached again to collect the forms. This was partly due to the unfamiliarity of the Saudi society with alternative methods, and partly related to socio-cultural values (appreciation and respect);
b) The presence of the researcher was intended to obtain spontaneous answers, probe when more information (or clarification) was needed, to measure the views of a broad range of community layers, and to deal with potential cases of illiteracy[40] or physical disability;
c) It supported asking more complex questions than other questionnaires could do (Bernard, 2006), and hence fostered the use of descriptive questions of who, what, where, how many, and how much, besides interpretive questions of how and why (Kitchenham, 2010);
d) Because identifying thermal comfort was primarily a subjective response, differing from person to person, place to place and from one time to another;

[40] The CDSI (2014) estimated the rate of illiteracy of the total population in 2013 was 5.6%. For the CIA World Factbook (2011), the rate was nearly 13%, while it was almost 13.5% in 2010 (Oxford Business Group, 2013). Drawing on these data, and the fact that the data of this research was collected in 2012, it could be estimated that the illiteracy rate ranged between 5.6-13%.

there was no more accurate technique than asking the participants directly *in situ*; and

e) Estimating the upper thermal comfort limit for pedestrians necessitated recording the four meteorological data *in situ*, together with the other two thermo-physiological factors, simultaneously, during the interview process, with every pedestrian agreeing to participate.

Moreover, this technique included measuring the pedestrians' attitudes, perceptions and preferences toward factors of the proposed tripartite model (Figure 1.12). These aspects are sometimes regarded as a silent language, and the associated perceptions are sometimes dubbed a hidden dimension (Hall, 1966). Thus, this approach was mainly used to decode such requirements.

5.6.2 Questionnaire design, scaling and structure

5.6.2.1 Questionnaire Structure

Derived from the proposed tripartite model, an original questionnaire form (in Arabic) was designed, and composed of a set of questions grouped under these three factors, plus a fourth part comprising general information (Appendix A). The questions were structured to move from general aspects (personal information) to more specific characteristics related to the pedestrians' socio-cultural attributes, and street design. Part I included independent variables, and Parts II to IV were of a mixed nature of dependent and independent variables.

1) ***Part I:*** consisted of profile of the participants, including body characteristics, and background information; for general description and to gather personal data necessary for the PET calculations (see section 5.6.6);

2) ***Part II:*** focused on measuring the pedestrians' thermal sensation regarding the immediate surroundings, to define outdoor thermal comfort conditions as perceived by the actual pedestrians' through correlations between their sensation and the actual microclimatic readings;

3) ***Part III:*** was dedicated to measuring certain socio-cultural attributes, including some components of the TIB, as discussed in Chapter Two in section 2.4.1, and also walking patterns and perceptions, to understand how the society perceives the walking experience and to identify level of impact of the socio-cultural context on walking. The structure of questions in this particular part followed a simple strategy by moving gradually from the general questions to the more complex items, so as to avoid the participants feeling bored; and

4) ***Part IV:*** was exclusively designed to allow the participants to evaluate particular characteristics of the existing street design (physically and spatially), with the aim to explore pedestrians' satisfaction with the quality of the existing conditions of the street space for walking. The questions in this part were largely derived from the major quality criteria of a good street design for walking, as summarised in Table 3-3 under section 3.2.8.

Almost the entire questionnaire relied on rating level of agreement with statements and 'closed-ended' questions, some of which (n=8) were provided with blank lines (semi-open-ended). The primary reasons behind such a strategy were: (a) to allow for the participants expressing some of their thoughts that the related questions may have inadvertently neglected; and (b) to ensure a quick filling-in process, so that the questionnaire does not take long to complete, under potentially uncomfortable climatic conditions.

5.6.2.2 Scaling Technique

For gauging the answers, it was acknowledged that three- to seven-point scales are generally appropriate for all practical purposes (Sahu, 2013). For this research, the majority of the items on the questionnaire used the 5-point Likert scale, varying from 'strongly agree' to 'strongly disagree', which gave the participants the opportunity to choose a neutral midpoint. In limited cases, according to the nature of the question posed, 3-point and 7-point scales were also used as explained below.

The questions focused on measuring frequency of walking in one of the four available walking places in Dammam used 3-point scale ('Very Frequently', 'Not Often' and 'Never'). Inquiring into preferences of microclimatic conditions also used a 3-point scale of 'Prefer Less', 'No Change' and 'Prefer More', as recommended by Alznafer (2014) (see section 3.3.7). Regarding the 7-point scale, it was only used to evaluate the thermal environment and comfort condition, as recommended by

ASHRAE (2009). However, this particular scale was slightly adjusted for the following reasons:

a) The ASHRAE scale was designed mainly for indoor settings, and hence small differences in thermal sensations (e.g. slightly warm/cool) are anticipated, whereas outdoor users could find it difficult to distinguish between such slight differences, particularly under harsh climatic conditions (Alznafer, 2014). Therefore, there was a need to adjust the scale to suit the outdoor conditions in Dammam;

b) Given the questionnaire was carried out during spring 2012, where typically air temperatures begin to reach ~40°C, an individual's feeling of very hot was highly anticipated. Accordingly, ASHRAE scale of *slightly warm*, *warm* and *hot* was replaced by *warm*, *hot* and *very hot* (Table 5-1); and

c) According to Auliciems and Szokolay (2007), the use of the ASHRAE scale to reflect individual's thermal satisfaction is cognitive, and hence influenced by past experience and socio-cultural factors. Therefore, the 7-point scale used was compatible with what the Saudi citizens are familiar with.

Table 5-1 The original and adjusted 7-point scale used in this research (Source: the author, after Alznafer, 2014: 108)

Original ASHRAE Scale	Cold	Cool	Slightly Cool	Neutral	Slightly Warm	Warm	Hot
ASHRAE Code	-3	-2	-1	0	+1	+2	+3
Adjusted scale	Cold	Cool	Slightly Cool	Neutral	*Warm*	*Hot*	*Very Hot*

Moreover, measuring the preferred personal distance for walking from other pedestrians was based on a 6-point scale varying from '≤ 1.2m' to '> 2.5m'. Because the close phase of the personal zone is defined by 46cm, which is reserved for intimate relationships, as discussed in Chapter Three (section 3.4.5.1), it was irrational to employ it in outdoor public spaces. Therefore, the far phase (1.2m) of the personal zone, which is also the close phase of the social zone, was the most appropriate. However, the participants had the opportunity to express the relevance of this aspect by selecting 'Unspecified'.

5.6.2.3 Questionnaire Design

When designing questionnaires, as recommended by Foddy (2001), Zeisel (2006) and Barrett and Finch (2014), it was essential for the researcher to carry out a pilot study, through which several questions of the questionnaire emerged (see section 5.6.3). Following this, the questionnaire was compiled and pretested to assess how the participants reacted, in order to draw out any potential deficiencies, and hence essential modifications to the final questionnaire were made.

It is worth mentioning here that the preliminary purpose for walking outside the street space in Dammam, which emerged through the pilot observation (see section 5.8.1), was mainly for exercise/sport. This meant that majority of the pedestrians were engaging in an activity that might affect their willingness to answer several pages of questions. Although the face-to-face situation could allow for the questionnaire to be long, in terms of the number of questions and time, coupled with the opportunity to pose complex questions, the questionnaire was kept short, in four pages, which was considered appropriate for the general public (Neuman, 2014).

Apart from utilising the questionnaire as a data collection technique, the questionnaire can play a dual role: ***receiving information*** and ***sending messages***. Thus, other considerations were regarded important, namely, the quality of the questionnaire design, paper size and graphical appearance. For this purpose, unlike the use of conventional A4 paper size that might seem too much, the form was designed in a folded A5-sized paper so that all the questions were printed on a single sheet of four pages (Appendix A.1). The basic reason behind adopting this format derived from the need to encourage the pedestrians to participate, by introducing the questionnaire in a handy form.

However, most importantly, in order to serve the dual function mentioned above, there was an additional underlying motive. Specifically, the researcher incorporated the sheet of questions into a well-designed cover page printed on high quality paper, on which an introductory statement, aim of the questionnaire and further information were included. Thus, the participants were urged to take and keep this. The purpose was to disseminate the significance of restoring walking as a lifestyle (message) among those who could not be interviewed (e.g. relatives, friends or colleagues), by looking at the information contained. Although such an approach could be argued to be costly, it was conducted with the ambition to increase public awareness towards the research problem, among as many as possible of the public.

5.6.3 Pretesting and piloting the questionnaire

Probably the way of pretesting the questionnaire at two stages, in addition to other procedures discussed later, are what made the methodology of this research innovative. The final version of the questionnaire was subjected to much revision, as a result of piloting and assessing the first and amended draft, before it was put into actual practice. In the two stages: (a) a preliminary draft was tested, in November 2011, among a small group of Saudi students and their children studying in Edinburgh (Figure 5.1), and (b) an amended version was tested on-site (in January 2012) through a field visit to one of the most popular walking tracks in Dammam (Figure 5.2).

Figure 5.1 Testing the first draft of the questionnaire among a small group of Saudi students and their children studying in Edinburgh

Figure 5.2 Testing the amended draft of the questionnaire along Al Muraikabat walking track

Although the first test was carried out indoors, unlike the actual implementation, the primary purposes were: (a) to identify strengths and weaknesses of the designed questionnaire; (b) to ensure forming socio-culturally compatible questions; and (c) to receive guidance and advice for improvements from other PhD students who applied the questionnaire method in their studies, particularly those who share similar concerns and interests with the researcher. For the second test, several objectives formed the basis for carrying out this activity, as follows:

a) To test the clarity of the posed questions, in terms of validating, revising and simplifying the wordings of questions in accordance with the feedback, so as to avoid ambiguity, ensure participants' comprehension of each question and to achieve neutrality and impartiality;

b) To measure the length of time taken to complete the questionnaire in the natural setting, and hence to detect whether the time spent was acceptable, too short or too long; and

c) To assess the validity of responses that could contribute to attaining the overall aim.

According to both constructive activities, six questions were added to the final questionnaire prior conducting the actual interviews. These questions focused on measuring dimensions that the researcher has initially excluded, or he had never thought about. One example is the questions related to certain 'push-and-pull' factors associated with car use. The reason behind neglecting such questions, in the preliminary version, is attributed to the influence of other researchers' works who suggested that the low fuel prices are one of the contributing factors to discourage walking in the Gulf countries (e.g. Fraser, 2012). However, piloting the questionnaire showed that most participants expressed their disagreement with such a preconception, and hence questions related to this area were added to the final draft. Another example is measuring the feasibility of numbering the length of pavements on encouraging the use of the street space for walking, modelled after the walking tracks (Figure 5.3) to estimate the distance walked[41].

[41] The reason for failure to observe this particular quality, to be included in the preliminary questionnaire, was attributed to the emergence of the concept of walking tracks while the researcher was doing this research abroad.

Figure 5.3 Incorporating a question about numbering of length of pavements, in the final questionnaire, was a result of piloting the questionnaire in the actual walking place

Moreover, as a result of piloting the questionnaire, the structure and questions of the final draft were modified following these guidelines:

a) The questionnaire consisted of separate parts, with their related questions, in order to facilitate analysing the answers;

b) The questions were carefully worded, since the wording of a question profoundly affects the answer (Foddy, 2001; Neuman, 2014; Brinkmann & Kvale, 2015; Bryman, 2016), and hence simple language was used, and technical terms were avoided, as much as possible;

c) Embarrassing or potentially embarrassing questions were avoided;

d) Ambiguous questions, or those potentially having more than one interpretation, were avoided; and

e) Leading questions were avoided, as possible (see Section 7.4.2–c).

5.6.4 Data collection procedures

The interviews were conducted during spring 2012, and took almost one month, from 30 April to 23 May. Most of the data was collected between 4pm and 9pm, according to the findings of the pilot observation (see section 5.8.1). In limited cases, the process was extended until 10pm, and took place at 1:15pm on one day only. During this latter implementation, a group of high school pupils, who were crossing King Khalid St., were interviewed. However, due to the blazing sun, the interviews were conducted under the shade of a surrounding building (Figure 5.4).

Figure 5.4 One of the interviews was conducted at 1:15pm only, on King Khalid St.

Moreover, the interviews were carried out on a walk-through basis, where pedestrians were randomly selected and asked to fill in the questionnaire. However, as previously mentioned, a fairly large number of the participants preferred their participation to take the form of structured interviews, where the researcher asked the questionnaire questions and the participants answered. Such a tendency can be interpreted as a preference for the ‘face-to-face’ situation.

Typically, the researcher approached the pedestrians and identified himself as an independent researcher carrying out a scientific study in the UK, for obtaining a PhD degree, while the assistant fieldwork team (section 5.8.3) introduced themselves within this role. It was clearly stated that participation was completely voluntary, and any collected information would be anonymous. They were also informed that filling in the questionnaire should not take longer than 10 minutes, at most.

Prior to their decision to participate, the pedestrians had the opportunity to look at the questionnaire, so as to assure them that all the questions were of a multiple-choice nature that could be answered with a tick. The reason for such an approach was to allow for the possibility of interviewing some people with no previous experience with the method itself.

Additionally, with the aim to avoid any feeling of discomfort or misunderstanding (see Footnote 43 below), the participants were advised that the researcher would take notes of their clothing level, while they were filling in the questionnaire, including women (as one of the sensitive socio-cultural concerns), but always in the presence of the female assistant (see section 5.8.3). Indeed, this was one of the advantages gained by piloting the questionnaire, and thus helped in determining how long the interview would take. Therefore, the participants were given a clarification about the relevance of recording such information, and how it would be used for calculating their thermal comfort.

This approach was simultaneously accompanied by recording the four microclimatic variables plus the two thermo-physiological factors, with every pedestrian agreeing to participate. With every participant, the completed questionnaire was reviewed by a member of the fieldwork team to check if all questions were answered; therefore, there were no missing values. Subsequently, all questionnaires were arranged for analysis processing.

Almost all participants were Arabic speakers, regardless of their nationalities and ethnicities, except seven participants, who represented 2.7% of the total sample. They were two Filipinos; one Indian and four Pakistanis. For this, they were asked if an interpreter, or an English version of the questionnaire, was needed. However, all asserted they had lived for quite long in the Arab region so that they speak and understand Arabic fairly well, plus broken English.

Accordingly, the researcher only explained the purpose of the questionnaire in Arabic, and used some English phrases when necessary, to ensure a clear understanding of the questions. This minor group was also given the opportunity to keep an English copy of the cover page, which was previously prepared for such a situation, with the same materials encompassed in the Arabic version (see Appendix A.2).

5.6.5 Instantaneous microclimate measurements

Owing to the fact that the participants were not bound to a specific location within the selected sites, the handheld device, as reviewed in Chapter Three (section 3.3.7), was very practical to use, for the following reasons:

a) The cost of any tools used for the data collection process is a central issue in any research project; this device has been found to be accessible and affordable commercially;

b) Being a multifunction device that is portable, lightweight and able to measure both low and high wind speeds, coupled with its fast-reading capability for instantaneous measurement of the microclimatic factors, it was a reliable device fitted well with nature of the field study;

c) Employing this device served best in both data collection methods. For example, one aspect of the participant observation (section 5.7.1) required the researcher to remain unknown to the pedestrians being observed, and hence the small size and appearance of this meter were very functional to fulfil this need; and

d) Because the multiple variables to be observed and measured simultaneously necessitated full concentration from the researcher, the ‘all in one’ feature, which this device provides, was a contributing factor in facilitating tasks of the field study, particularly when several items were carried.

Therefore, three devices (*Lutron 4-in-1 Environmental Meter*, model LM-8000) (Figure 5.5) were provided for each group of the fieldwork team, to record the four microclimatic variables: air temperature (Ta); globe temperature (Tg); relative humidity (RH); and wind velocity (v), at the time of each interview. All these factors were measured approximately at a height of 1.1m, as recommended by ASHRAE (2013) and other studies (see sections 3.3.2 & 3.3.6.1). Although the device lacks a built-in sensor for measuring the Tg, which is necessary to estimate the mean radiant temperature (Tmrt), it is capable of doing so by connecting an external globe thermometer through the built-in Type-K thermocouple input socket.

Therefore, the researcher personally consulted Dr Badran Alznafer, who assembled the same thermometer, for instructions to construct the globe temperature probe. Hence, the thermometer (Figure 5.5) was constructed by placing a thermistor (type: AVX 2000Ω) in the centre of a Table-Tennis ball (diameter (Ø) = 38mm and emissivity (ε) = 0.95), and connected with a thermocouple wire. The ball was then painted with a matt finish black colour, and glued to a hollow tube through which the wire was connected to the device.

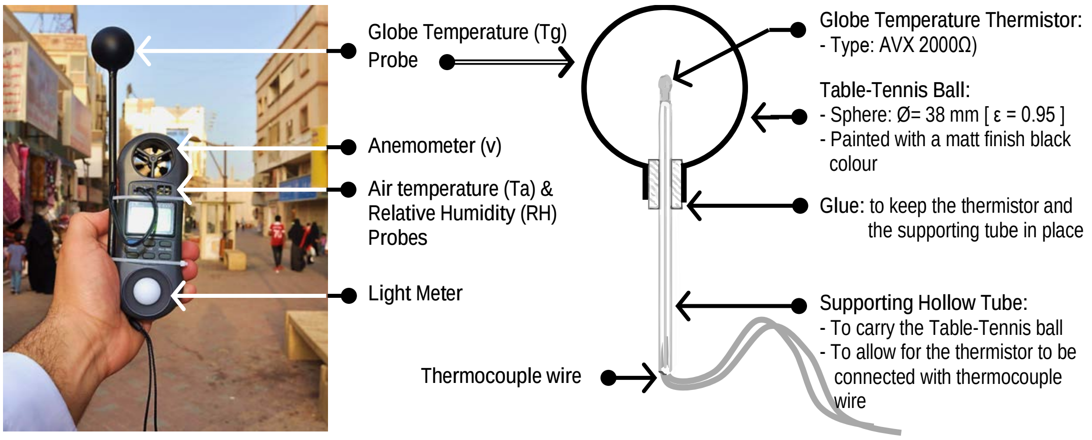

Figure 5.5 The handheld Environmental Meter used during the field study, and a detailed diagram showing the assembled globe thermometer (Source: the author)

5.6.6 Calculation procedures to measure outdoor thermal comfort

Defining the upper thermal comfort limit for the participants, as one of the major objectives of this research, necessitated combining the four recorded factors mentioned above with the two observed thermo-physiological factors: level of the physical activity (Met) and values of clothing level (clo) (see section 3.3.5). This was attained by application of the ***PET*** index through use of the ***RayMan*** Software. The PET index was employed due to its advantages over the other thermal indices reviewed in Chapter Three (section 3.3.6.1). However, this process often involves mathematical complexities in estimating the PET values.

With the aim of facilitating such a process, RayMan version 2.1 was used, and required the inputs of: (a) Met[42]; (b) clo[43]; (c) Ta; (d) v; (e) RH; and (f) Tmrt. While variables (a) and (b) were being observed for each participant, (c) to (e) were measured simultaneously and (f) was estimated later. By entering the measured values of Tg, Ta and v into ***Microsoft Excel***, the Tmrt values were estimated using

[42] The list used for estimating values of metabolic rates for various types of activities (Appendix D.3), was adopted from ASHRAE (2004).

[43] In order to avoid any feeling of embarrassment or discomfort by the participants, particularly women, by posing such a question, which is considered socio-culturally unacceptable, the clothing insulation values (clo) of each participant were estimated by the author. This was done, according to the sum of the insulation values of individual garments, based on data from three sources. While the list of clothing insulation values, for the participants who were wearing western-style clothes (Appendix D.1) was adopted from McCullough et al. (1984) and ASHRAE (2009), estimating the clothing insulation values for the participants who were wearing traditional Gulf clothing (Appendix D.2) was adopted from Al-Ajmi et al. (2008).

Equation 2 (see section 3.3.7–B), and hence all data were recorded on every questionnaire form before entering the data into RayMan.

Subsequently, these six factors were converted into PET values, which were generated through use of RayMan in a text file format (.DAT), in order to process all collected data statistically in ***SPSS***[44]. A ***Linear Regression*** analysis was then carried out, where the PET was the dependent variable and the Ta, Tg, RH and v were the independent variables. This was done to correlate the output PET values to the participants' ratings (preferences) for each of the four environmental parameters, and *in situ* measurements. Eventually, the microclimatic conditions responsible for defining the upper thermal comfort limit, after which the pedestrians would feel discomfort in the outdoor spaces of Dammam, were identified.

5.6.7 Data analysis

All collected data were numerically coded and inserted directly into Excel, including the PET values generated by RayMan, then transferred into SPSS version 20, where the statistical analysis phase was performed. The eight semi-open-ended questions (section 5.6.2.1), were processed and analysed manually, where applicable. This was because to the fact that only six participants (n=6) added some comments to justify their answers, whereas the majority left the 'reason' field blank.

The first analysis was descriptive, so as to highlight the preliminary findings of all data collected, including the participants' profiles, attitudes, perceptions and preferences towards the three proposed factors. This was followed by 'Linear Regression' to Part II of the questionnaire only, for estimating the upper thermal comfort limit of the pedestrians. This was because of the capability of this analytical tool to explain the relationship between one dependent variable and other independent variables, and thus, in prediction. This analysis partly answered the research sub-question (4), through identifying the microclimatic variables associated with a pedestrian's thermal comfort outdoors.

[44] Statistical Package for the Social Sciences.

5.7 Participant observation

Observation is a basic human behaviour in many daily activities, and a well-known qualitative technique[45]. Jacobs (1961) was deeply interested in the concept of direct observation, emphasising that researchers should look closely at conditions of actual settings, as used by actual users. She goes on to say: "While you are looking, you might as well also listen, linger and think about what you see" (Jacobs, 1961: xiii). This means researchers do not only record what was actually occurring in the space, but should also reflect on their experience, feelings and thoughts.

Consequently, any observational activity aims primarily to gain a better insight into the research problem (Bechtel & Zeisel, 1987), as well as to obtain a deeper and objective knowledge about the physical setting itself (Golicnik, 2005). Marcus and Francis (1998) further describe the strength of doing observation in a way that:

> "with a very limited investment of time the investigator can achieve considerable insight into the actual use of designed places – a vast improvement over the conjecture and guesswork generated by studying a site plan from the remove of the studio or office" (Marcus & Francis, 1998: 346).

Among the examples of the role of observation in understanding the relationship between a particular setting and its users are the works of Hall (1966), Whyte (1993), Gehl and Gemzøe (1996), Gehl (2010) and Molnar (2015). All drew their findings heavily from observing users' behaviours and interpersonal relationships as occurring in the actual settings. Their observation activities involved living in the actual location and acting the same way as the actual users do for several weeks, months or even years: for example, Whyte was a participant observer for over three years.

Gehl and Svarre (2013) emphasise that observation is the primary tool for urban designers, which provides interesting information about the interaction of public life and urban space, contributing to gain a better understanding of why some spaces are used and others are not, and adds a dimension that interviews alone could never capture. In the same context, Zeisel stresses that:

[45] It can be also quantitative when, for example, counting the number of users is central for the research.

> "The better information designers have about how the people they design for behave in physical settings and how those people relate to or exclude other people, the better they can control the behavioral side effects of the design decisions they make" (Zeisel, 1984: 123).

Such a direct participation and observation can allow researchers to reveal much more than ordinary evidence (Zeisel, 2006; Bryman, 2016). Accordingly, landscape architects are highly advised to be physically present in the actual setting, because any good analysis of a public outdoor space must begin by spending time there, watching how the place is used and recording as much information as possible (Al-Abdullah, 1998). For this purpose, among all the types of observation, participant observation is the most productive type, due to its direct interaction with actual users in their actual settings (Bechtel & Zeisel, 1987; Merriam, 2002; Hume & Mulcock, 2004; DeWalt & DeWalt, 2011; Spradley, 2016).

5.7.1 Defining the participant observation and justifying its selection

This technique differs from other types[46] of observation, in that it requires the researcher to gather data by taking a participative role in the actual setting, interact with its actual users and, if necessary, talk to them. In this case, the researcher is an ***insider*** 'emic perspective', to understand the setting and phenomenon as it is typically seen and used by its actual users, but at the same time, as an ***outsider***, 'etic perspective', to reveal and decode the nature of that setting and phenomenon (Merriam, 1998; Brewer, 2000; Bernard, 2006; Mligo, 2013; Miles et al., 2014).

The central element of participant observation, in the actual setting, depends on the researcher immersing "himself in it, learning, as far as possible, to think, feel, and sometimes act as a member of its culture and at the same time as a trained anthropologist from another culture" (Powdermaker, 1966: 9). Moreover, Hoyle et al. (2002) and Zeisel (2006) argue that the selection of behaviour/activity to observe is typically guided by the focus of interest, and by practical and ethical concerns that limit what is observable. Hence, the participant observation, in this research, was selective as to where, what and when to observe.

[46] For example, observing the subjects from behind a one-way mirror.

Thus, the need to obtain reliable data regarding pedestrians' actual experience requires the presence of the researcher in the street space, physically, and to play dual roles; as insider (user) and outsider (researcher). In the first role, the researcher considers himself as a participant who practises the same activity and behaviour as any actual user does in situ. The second role involves visual observation in which the researcher traces the activities done by others and records every movement and behaviour occurs in the space under study. By doing so, the data will not be generated only through watching and recording what the actual pedestrians naturally do, but also the personal experience of the researcher will be part of the data. As a result of sharing the same street space, the researcher was the main instrument of data collection (Burgess, 2006; Bernard, 2006; Guest et al., 2013; Spradley, 2016).

This is important, as some information would be only visible to insiders, and hence the outcome would be "a compelling blend of outsider objectivity and insider knowledge, exemplifying both insider and outsider perspectives" (Guest et al., 2013: 79). This supports Brewer's view for the need to:

> "maintain the balance between 'insider' and 'outsider' status; to identify with the people under study and get close to them, but maintaining a professional distance which permits adequate observation and data collection" (Brewer, 2000: 59-60).

The strength of the participant observation lies in being a powerful tool for understanding a particular lifestyle (walking) of a particular group (pedestrians) of a particular case (Dammam), in a particular physical setting (streets). Therefore, it typically involves a large amount of primary data, whether collected or analysed, as well as criteria of site selection in which the observation will take place.

Moreover, bearing in mind the lack of previous data regarding pedestrians in the KSA, participant observation was recognised as the best technique when first-hand knowledge or a fresh perspective of the phenomenon under study is desired (Merriam, 2002; Spradley, 2016). Drawing on the purpose of adopting this method as a supporting technique to the interviews (see section 5.5), coupled with time limitation and the impossibility of observing everything, the required data from employing the observation method was confined to four goals:

(a) to gain a better insight into the pedestrians actual walking patterns; (b) to identify the level of impact of the existing conditions of the street space on walking; (c) to identify the walkers' proximity to each other (personal space); and (d) to specify (within the pavement space) where they sit or stand, what type of activities they engage in and what is the most frequent time of the day at which the pedestrian traffic becomes considerable. Once these issues had been explored, any similarities, variations, conflicts or nuances, between pedestrians' responses to the questionnaire and their actual use of the street space, would be identified.

In fact, these four goals can be grouped into two dimensions of unobtrusive observation of the natural behaviour (walking) and the natural setting (street). Hoyle et al. (2002) defines natural behaviour as that activity which is naturally occurring, with or without the presence of the researcher, in its natural setting being investigated. The natural setting refers to a physical context that was not established for research purposes.

Behaviour is usually expressed as forms of various interactions between the users (pedestrians) and their surrounding context (other pedestrians and/or space). In this regard, Zeisel (2006) argues that observing the users' behaviour in the actual settings generates data about users' activities and the relationships needed to sustain them, about regularities of behaviour, about expected uses and misuses of spaces and about behavioural opportunities and constraints that spaces provide.

5.7.2 Observation vantage point and procedure

Drawing on the fact that walking is a normal human activity, where typically, in the Saudi context, nobody cares to observe, and streets being the daily landscape for everyone, any unusual activities would certainly expose the researcher to the pedestrians. Hence, this would disrupt the essence of participant observation, where the key role of the researcher, as an insider and outsider, would be lost. Consequently, choosing an appropriate observation position, which would not contribute to altering the pedestrians' behaviour, was an extremely important criterion, and hence, has become an innovative approach in this research.

In order for the researcher to remain unknown, and to avoid the ‘Hawthorne’[47] effect, it was essential to search for a strategic vantage point within the street space that satisfied the following criteria, collectively or partially:

a) Proximity to the pedestrians, in order to closely observe their behaviour, activities and interactions, as well as tracing their walking patterns, on both sides of the street, without blocking the overall scene;

b) A position that facilitates the use of observation equipment, i.e. cameras, maps and microclimate measuring devices; and

c) A common place where frequent presence of the observation team, individually or collectively, is considered normal, and would not cause disruption to movement flow.

At first glance, such criteria may suggest the selection of high locations, such as upper floors or roof tops of tall buildings; however, such an approach was deficient to fulfil the above requirements, due to: (a) the lack of tall public structures within the selected streets; (b) difficulty in contacting private owners to use their properties; (c) some sections of the selected streets were irregular and furnished with palm trees, so that it was difficult to have an unobstructed view towards the pedestrians and (d) the microclimate would not be represented.

Accordingly, the researcher adopted the position of the ‘secret outsider’ (Zeisel, 1984; Merriam, 1998; Bernard, 2006; Mligo, 2013; Miles et al., 2014), or ‘the hidden observer’ (Bechtel & Zeisel, 1987). Brewer (2000) describes such a position as the use of an ‘existing role’, or ‘social situation’ (Spradley, 2016) within the setting, from which to do the observation. Hence, locations of street vendors were selected as the optimal observation settings.

Justifying this choice, street vendors (Figure 5.6) are widely scattered within the selected streets, and occupy large portions of the space in fixed spots, although illegal. Most importantly, their presence is regarded ordinary, natural and part of the daily scene. Although the fieldwork team (see section 5.8.3) were fully familiar with

[47] The ‘Hawthorne Effect’ is a form of behavioural change of individuals as a result of their awareness or foreknowledge of being observed, as part of an experiment. This often drives the subjects to behave in a manner contrary to their natural behaviour; thus, any collected data will not be realistic, reliable or truthful (Shaughnessy et al., 2015).

the selected streets, their involvement took a new role, and hence it was a central procedure to carry out several visits to the selected streets. The purpose was to develop a gradual socialisation context with the selected vendors, based on their locations within the space, but central to cover both sides of the street, in order to convince them to cooperate in this activity. This was guided by Brewer's view who maintains that:

> "the observer must win acceptance in the new role, undergo an extensive period of resocialization into the practices and values of the group, give an enormous time commitment to the field in order to experience the full range of the events and activities in the setting" (Brewer, 2000: 61).

Figure 5.6 The selection of observation vantage points were locations of street vendors

5.7.3 Observation devices and personal space measuring techniques

There are various types of media which can be used to document the pedestrians' experience during the observation process. However, the selection of any of these tools depends mainly on how much information the problem demands, and how much the observer already knows about the phenomenon and context to be observed (Zeisel, 2006; DeWalt & DeWalt, 2011; Gehl & Svarre, 2013; Spradley, 2016).

Proceeding from the adopted role and style of the observation in this research, the field study was conducted with the naked eye of the researcher, combined with the use of mapping (including annotated sketches), note-taking and occasionally photographing. Additionally, two techniques for estimating the personal space during walking were employed, although deciding which one to utilise depended on contextual circumstances and time of observation.

Mapping was the primary tool of recording and analysis, to identify how the pedestrians actually use the existing street space; by means of directly observing their walking patterns and activities they are engaged in, while standing or sitting.

Drawing on the discussions of Bechtel et al. (1987), Bechtel and Zeisel (1987) and Gehl & Svarre (2013), the mechanism relied directly on locating the true location of these aspects, as they naturally occurred within a specific time frame adhered to[48], on a drawn-to-scale plan of the selected streets. This was accomplished by coding and symbolising various types of activities, included counting the pedestrians.

Photographs were mainly used for visual documentation; zooming in on situations or fast-freezing the moment. The aim was to sharpen the gaze of the researcher in order to analyse the situation later more closely (Gehl & Svarre, 2013). Hence, a better understanding and interpretation of the cause-and-effect relationship between street design and walking could be linked in time and space.

Moreover, identifying patterns of the pedestrians' movement indirectly, within the pavement space, was possible by tracing their footprints, specifically, by looking at the difference in colour of the paving material. For example, the most frequently used part of the pavement was mostly reddish[49], while the less frequent part was dusty, and hence attested to the lines where the pedestrians were typically walking. Similarly, locations of stationary activities (standing or sitting) were also observed, either if the pedestrians were present or by tracing things or marks they left behind, such as spots on the ground, or on benches or bollards.

Furthermore, the instantaneous measurement of the personal space among pedestrians, while simultaneously taking notes, photographing and coding behaviours and activities on maps, was a sensitive and even tricky mechanism, as any use of tools which were impractical or inappropriate to this particular context could lead to the failure of the observation. Therefore, the researcher followed two quick checking-distance approaches, without being exposed to the pedestrians.

The first approach was the '***Thumbnail-on-the-pencil***' or '***sight-size***' method, which is a classical visual technique of sighting and measuring objects, and which has been utilised in the field of Art and Architecture for centuries, as an on-site measurement unit. Although this method has been acknowledged to be less accurate, it is still a

[48] According to the intensity of the pedestrian traffic, the time frame was half an hour, on average.
[49] This is attributed to the fact that most pavements of city centre streets are paved with red interlock pavers.

helpful source in gaining a better understanding and approximate measure of dimensions (Nice, 2010; Edwards, 2013). Chiefly, it depends on the use of vertical dimensional proportions as a measuring unit for horizontal distances, on a visual estimate basis.

This technique was employed by laying a pencil against a known-height person[50] or vertical fixed feature, and then turned into horizontal position against the distance between two pedestrians. This process was repeated several times, as necessary, until the distance, between the two, was covered (Figure 5.7). Although the researcher is a landscape architect, who is well familiar with such a method, an extra practice was performed, prior to the actual observation being conducted, in order to do it successfully with minimal or negligible errors by the fieldwork team.

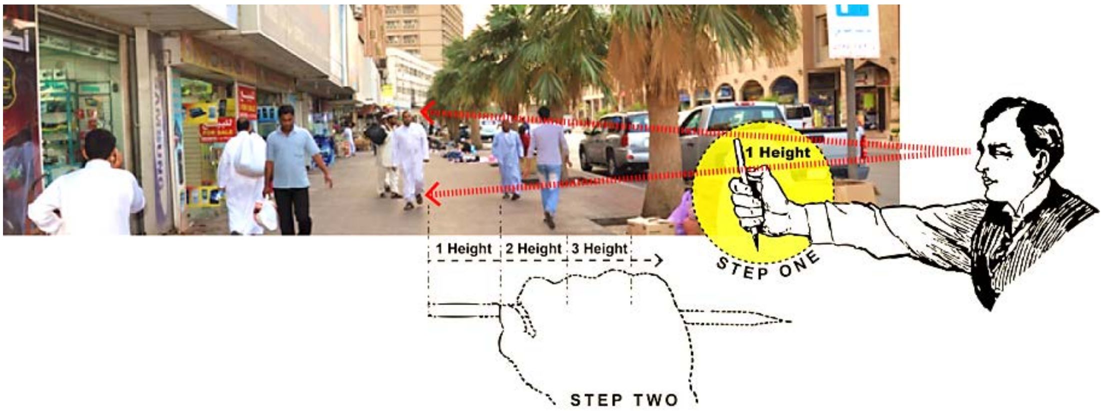

Figure 5.7 Illustration showing how the 'thumbnail-on-the-pencil' method was utilised on-site, during the observation process (Source: the author)

The second approach was the use of a ***Laser Distance Measuring Device*** (model BOSCH-PLR 50). Although it is a more accurate, fast-response and reliable device, it was mostly employed during evening observations. It enabled the researcher to measure far distances (up to 50m), without being exposed to the pedestrians, so that a distance with the pedestrians, to support the 'secret outsider' position, was maintained (Figure 5.8). Using this tool was as simple as pressing the laser pointer

[50] Selection of the pedestrian was based on who appeared to be at average height of men and average height of women; 168cm and 156cm respectively, according to the latest statistics for Saudi Arabia (Bjelica et al., 2012: 77).

twice between two pedestrians, mainly on foot. For this, the fieldwork team (see section 5.8.2) was provided with several units of this device[51].

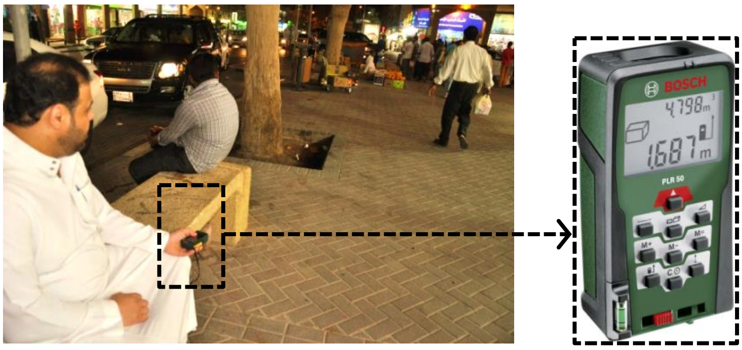

Figure 5.8 The laser distance measuring device during the observation

5.7.4 Data collection protocol

In order to obtain a representative sample, and also to ensure consistency of microclimatic conditions in both methods applied, field observations were conducted in the same period as the interviews (spring 2012). The observation activities were carried out from the last day of the week (Wednesday) for three consecutive days in each selected street. This decision was derived from the pilot observation (section 5.8.1) and was suggested by the criteria of site selection (section 5.8.2), which showed that this selection of streets, time and days was an ‘ideal laboratory’ and the appropriate period of time for observing pedestrian traffic and activities. During weekends[52], the selected streets were found to witness a great increase in pedestrian activities, and hence provided a good opportunity for the researcher to become just another face in the crowd. This was important to avoid drawing attention and to maintain the position of insider and outsider. Therefore, King Saud Street was the first site selected for the observation activities, which were conducted from Wednesday to Friday (2-4 May 2012), and the 13th Street was the second case study, which covered the period from 9-11 May 2012. In both streets, the observations took place from 4 to 7pm.

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[51] These devices were supplied by the College of Architecture and Planning at University of Dammam

[52] At the time of observation, the official weekend, in Saudi Arabia, was Thursday-Friday, but was shifted to Friday-Saturday, on 29 June 2013.

Before conducting the actual observation, two fundamental procedures had been conducted *in situ*: (a) physical components, land uses and building heights in each predefined segment for observation (see section 5.8.2–A) were updated on a paper map through a walk-by observation. This procedure was essential in order to keep the observers focused on the subjects during the actual data collection process, by minimising any potential source of disruption[53] while carrying out the observation. Furthermore, (b) the work team members were taken for a site visit to the selected streets, where they were introduced to the street vendors whom they would join during the fieldwork activities. For the observers, this was essential for socialising purposes, and to become thoroughly familiarised with the predefined segments, physically and spatially. During this experience, the team was exposed to the types of activities and patterns of behaviour expected to be observed. The members, including the researcher himself, were asked to record in their sketchbooks what they saw, heard, smelled and felt. However, not all of these attributes would be covered in, or become part of the actual fieldwork, as some were beyond the scope of the observation purpose. Nevertheless, this approach was considered as a necessary training, so that it was done with the aim of helping the observers to concentrate on several variables *in situ* at once, as well as to establish a common basis for the observation protocol.

Next, the work team, which consisted of ten members including the researcher, was divided into four groups: two groups of two observers each, and the other two with three observers in each. These four groups were then distributed so that each pair of groups covered a different side of the street selected: that is, four observational zones within the observation segment. The beginning and end of each observation zone was mainly defined by property limits of adjacent buildings or the edge of a pathway (Figure 5.9). In order to avoid overlaps between the groups in observing the pedestrians, the procedural work was based on each group observing the pedestrians

[53] For instance, the lack of incorporating any physical attributes, which were recently introduced into the street under observation, into the maps, could have contributed in the neglect of observing certain aspects related to the pedestrians, owing to the need for such attributes to be observed and coded at precisely the same location.

entering or arriving at their zone limits, from a specific side, and heading towards the next group, whether on the same pavement or on the opposite side of the street.

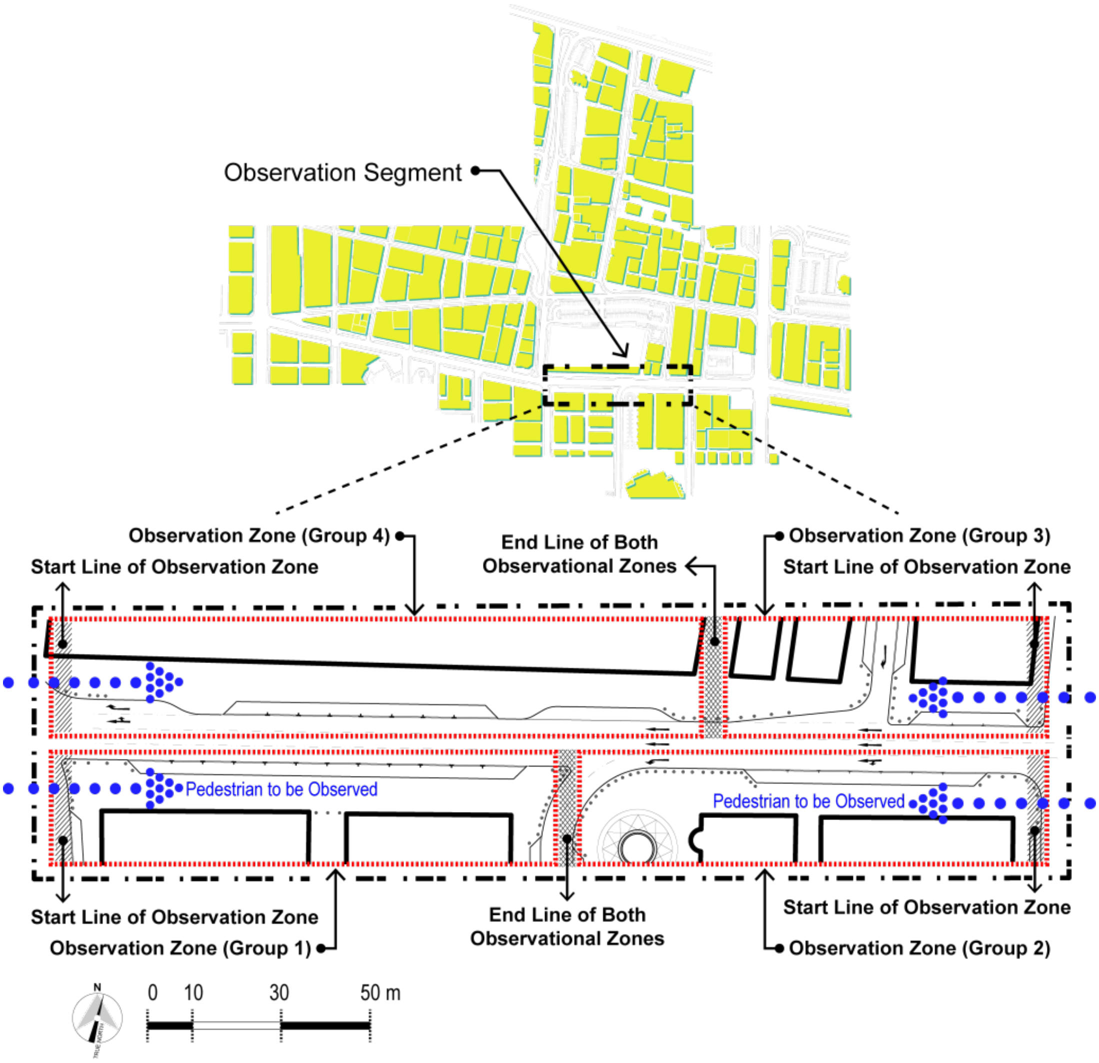

Figure 5.9 Illustration of the observation protocol

Owing to the limited number of the handheld environmental monitoring devices, coupled with the need to avoid overlaps among the observers in the same group, an observer (in sitting position) was tasked with: (a) recording weather conditions every 15 minutes for each observation period; and (b) mapping stationary activities (sitting, standing and selling) within the delineated boundary of his observation zone. Hence, the other observer(s) were focused on recording the other required observation contents**.** Moreover, in order for the observers to avoid becoming fatigued or bored, as well as to achieve equality of tasks and distribute the workload impartially, they exchanged their roles between observation periods, and sometimes between observation rounds.

Typically, every observer was provided with several copies of a paper map; a drawn-to-scale plan of the observation segment, with a table of coded attributes of the required observation contents included on each map. The basic instructions were to document certain patterns of behaviour and types of activities as they occurred in the observation zone, mainly by gender, using the coded attributes. Thus, two ink pens were provided for every observer; the red was used for female-related aspects whereas the blue was used for male-related observations. Combined with these, each observation group was provided with the necessary handheld devices to record the weather conditions and measure personal space between walkers. Due to the limited resources available to the researcher, the observers were kindly asked to use their own smart phones to capture specific behavioural events or phenomena for later analysis. However, the major visual materials were recorded by the researcher using a DSLR camera (model: Nikon D90 equipped with a mid-range zoom lens with 18-105mm focal range).

From within each observation zone, the observers recorded on the maps the required observation contents. These contents were specifically developed based on the role of the observation method adopted in the study, which is to explore the actual use of urban streets in Dammam. The contents included: (a) observing and describing pedestrians of all ages, genders and ethnicity groups, whether they appeared individually or in groups, as this was one of the socio-cultural attributes to focus on; (b) tracking pedestrians' activities and behaviour, whether passive or active (walking, sitting, standing, window shopping, eating, chit-chat while sitting or standing, or even observing other people); (c) pinpointing locations of both the patterns of behaviour and types of activities on maps (in terms of under shade of buildings or trees, close to property limits, at the edge zone, throughway zone or frontage zone, between buildings, on benches or bollards and around corners); (d) mapping walking patterns (straight or zigzag, including road crossing); and (e) tracing how far a pedestrian was walking from other pedestrians (personal space).

Proceeding from the results of the pilot observation, the observation process was divided into three periods on each observation day, according to the pedestrian traffic: 4-5 pm, 5-6 pm and 6-7 pm. The procedural work or tactic was that each observer, except the one in the sitting position, was to follow from a distance the next pedestrian to cross the agreed upon starting line of each observation zone, once the previous one had been recorded. This was accompanied by the following simple instructions: each pair of observers must not walk in close proximity to each other while observing, whether side by side or approaching each other. This was maintained so as to avoid drawing the pedestrians' attention to their activities.

During the first observation period, it was feasible to observe and record almost every pedestrian who crossed the starting line, due to the relatively low pedestrian traffic. However, the noticeable increase in pedestrian activities during the other two periods, although this was expected, meant that the pavement space was typically crowded, thus creating an obstructed view to the observer in the sitting position. Therefore, unlike the others, whose tasks were originally based on following pedestrians, during the last two periods this observer was compelled to leave his place to record the required contents entrusted to him through walk-by observation. Each observation round was completed when the subject crossed over the predefined boundary of the observation segment, and not only the observation zone. At the end of each observation day, all collected data were then digitised, through Adobe Illustrator, by means of creating multiple layers. This has been done by tracing over the observed aspects mapped on the paper map, after it had been scanned. Every observed aspect or activity was mapped in a separate layer[54], based on gender, ethnicity and time of observation.

5.7.5 Data analysis

The recorded observations obtained for this research contained data about sequences of behaviour and activities that took place in a specific urban space (street) involving

[54] For example, one layer was created, in Adobe Illustrator, to map transient walking, using dotted lines, and another one for continuous walking, using continuous lines, for every observation period at the end of each observation day. For both types of walks, two different colours were used to distinguish between genders, while two styles of arrowheads have been used to differentiate between the ethnic groups that were regularly observed outdoors in Dammam (i.e. Arabs and Asians).

specific users (pedestrians). By using maps, plans and photos, the content of the observations was analysed, which relied on exploring the occurrence or repetition of particular categories of activities or behaviour. This approach has been adopted from a commonly used technique termed ‘Content Analysis’.

The content analysis is considered, in the field of research methodology, a non-reactive method, which means the observed pedestrians are not aware that information about them is part of a study. This reinforces the concept of the participant observation, where the researcher is not exposed to those being observed. The basic procedure in content analysis is to design categories or themes that are pertinent to the research focus, and to sort all occurrences of relevant activities or other observed aspects into these categories (Miles et al., 2014; Neuman, 2014; Shaughnessy et al., 2015).

It has been also deemed a useful approach to help in understanding behaviour-related attributes of the use of outdoor spaces in KSA (BaHammam, 1995; 2004 and 2009; Al-Abdullah, 1998). All the sources mentioned here stress that the designed categories must be clearly defined and developed according to the occurrence of a specific behavioural event (walking), and that the derived categories must also remain focused on the research question. Therefore, the content to be analysed included pedestrians’ behaviour, activities, walking patterns and preferred personal space, as these occurred in the actual street space.

5.8 Preparations and procedures for the field data collection

5.8.1 The pilot observation and its role in guiding the field study

This research is almost certainly the first study that attempts to bridge the gap in studies into restoring walking into the street space in Saudi Arabia, especially through approaching the pedestrians in their real environments. This means that there was a lot of information to ask, observe and record, including activities, behaviour and walking patterns. This was coupled with the fact it was impossible to cover everything and everywhere. Thus, it was essential to carry out a pilot study in order to narrow down ‘what’ to be asked and observed, as well as ‘when’ and ‘where’ to conduct the actual data collection.

Two pilot observations were conducted, during this research. The first was carried out in 2010, after commencing the PhD programme, as a preliminary investigation. The aim was to experience the street environment as a pedestrian and as a car driver, and hence to narrow down the scope of the study, and assess the best approach for addressing the present research problem. The second took place in 2012, after the conceptual model was developed, with the aim to verify the proposed components.

Although both activities established rich knowledge to better understand the nature of the challenge under investigation, the second observation was more productive. The outcomes gained from this activity not only contributed in selecting the participant observation as the most appropriate observation method, but also in identifying its role in the study, and guiding the actual data collection process, including the interviews. Even though the researcher personally belongs to the case study context, the pilot observation helps “to understand the broadness of the problem, which in turn will help him/her in his/her endeavour to narrow down the problem” (Mligo, 2013: 60). Therefore, the second observation was mainly assessment and familiarisation, as well as to ensure the reliability and validity of both techniques adopted, and to make necessary arrangements for carrying out the field study.

Whenever it was possible[55], the pedestrians were observed in several walking tracks and different types of streets, as well as along Dammam Corniche. However, in some circumstances, they were also interviewed, amicably and informally, to probe about the rationale behind some of their attitudes or conduct, which were incomprehensible to the researcher. Carrying out the pilot observation was essential to increase the external validity of the findings. External validity is defined as the extent to which the results of the study extend beyond the limited sample size collected in the study per se, and hence can be generalised to a wider range of settings, situations and users (Neuman, 2014; Shaughnessy et al., 2015).

In this regard, Shaughnessy et al. (2015) argue that by observing the targeted users in different situations and settings, researchers would be capable of reducing the

[55] In terms of whether the observation was intentionally planned, or just on the side-line during family picnicking and shopping.

possibility of their results being particular to that situation. They further assert that behaviours and activities of targeted users often change due to the impact of the surrounding context in which they were investigated. This means that characteristics of the surrounding environment exert a dominant influence on behaviour. This reconfirms Rapoport's argument (1991) that the characteristics of the physical environment can be supportive of or inhibiting towards behaviours. For example, pedestrians do not always walk and behave the same way when pavements are available as they do when no walking spaces are dedicated.

Therefore, the settings in which walking can be expected to occur naturally, with sufficient regularity of pedestrians, were selected (see section 5.8.2) to make the use of both adopted methods practical. Therefore, one of the objectives of conducting the pilot observation was to define these settings, whereas the actual data collection was conducted later, in the selected settings.

From the pilot observation, several facts were revealed, which informed the actual data collection process, including the nature and role of both adopted methods:

- **a)** It was clear that high intensity of pedestrian traffic typically occurs at weekends, regardless of the site;
- **b)** The actual beginning of pedestrian activities and movement was observed late afternoon; specifically, from after 4pm, while the peak time was typically around 7pm;
- **c)** The preliminary finding showed that pedestrians mostly go walking for exercise/sport or for health reasons in the available urban spaces, but not streets;
- **d)** This activity reconfirmed the absence or withdrawal of pedestrians from the street space; i.e. there was no significant pedestrian movement observed on streets, except in the city centre area;
- **e)** Interrupting the observed pedestrians, although it was welcomed, made them behave differently;
- **f)** Women were the majority users of walking tracks, while walkways along Dammam Corniche witnessed equal use by both genders;

g) The usual pedestrians on streets, if observed, were not native people, whereas different nationalities, ages and genders were recognised in all other urban spaces; and

h) Children of primary school age were noticeably absent from all observed sites (see section 5.8.4–c). The underlying reason for their disappearance could be related to social concerns of parents about their children being out of doors. This interpretation may be supported by the observation that children appear to be increasingly seen in indoor environments, for example, shopping malls and indoor play zones.

5.8.2 Criteria of site selection for the actual data collection

For purposive and representative sampling, once the location of the case study was defined (Dammam city) and who was to be investigated (pedestrians), it was fundamental to identify what criteria were essential in choosing the sites in which the targeted users would be interviewed and observed (Foddy, 2001; Merriam, 2002; Brinkmann & Kvale, 2015). The basic principle, in the present study, was to interview and observe the pedestrians in their actual walking environments.

Thus, a considerable effort during the pilot observation was devoted to the selection of the most appropriate sites where the actual pedestrians could be interviewed and observed. Hence, four cases were identified: urban streets, Corniche walkways, walking tracks and shopping malls, although they are not four sites. This selection was attributed to the fact that these are the only available places in Dammam where the pedestrians typically go to walk. In this context, it has been recognised that if the same phenomenon can be studied in multiple cases, then each case study:

> "reveals a discovery but in which the replication across cases also adds up to a significant theoretical breakthrough. This situation truly lends itself to the production of an exemplary case study" (Yin, 2014: 201-202).

However, Mligo (2013) emphasises how effective is the collection of much data on a few cases rather than little data on many cases to gain rich insights into a phenomenon. Accordingly, eight sites were selected for collecting data: (1) the walking track of the Eid Mosque, (2) the walking track of the Muraikbat Park, (3) the walkway of Dammam Corniche, (4) King Khalid Street, (5) King Saud Street, (6) 13th Street, (7) Dhahran Mall and (8) Alfarabi Street, at the side of a primary school (see section 5.8.4–c). Figure 5.10 shows the location of the selected sites and Table 5-2 provides brief information about each one. The following paragraphs justify the choice of the selected sites.

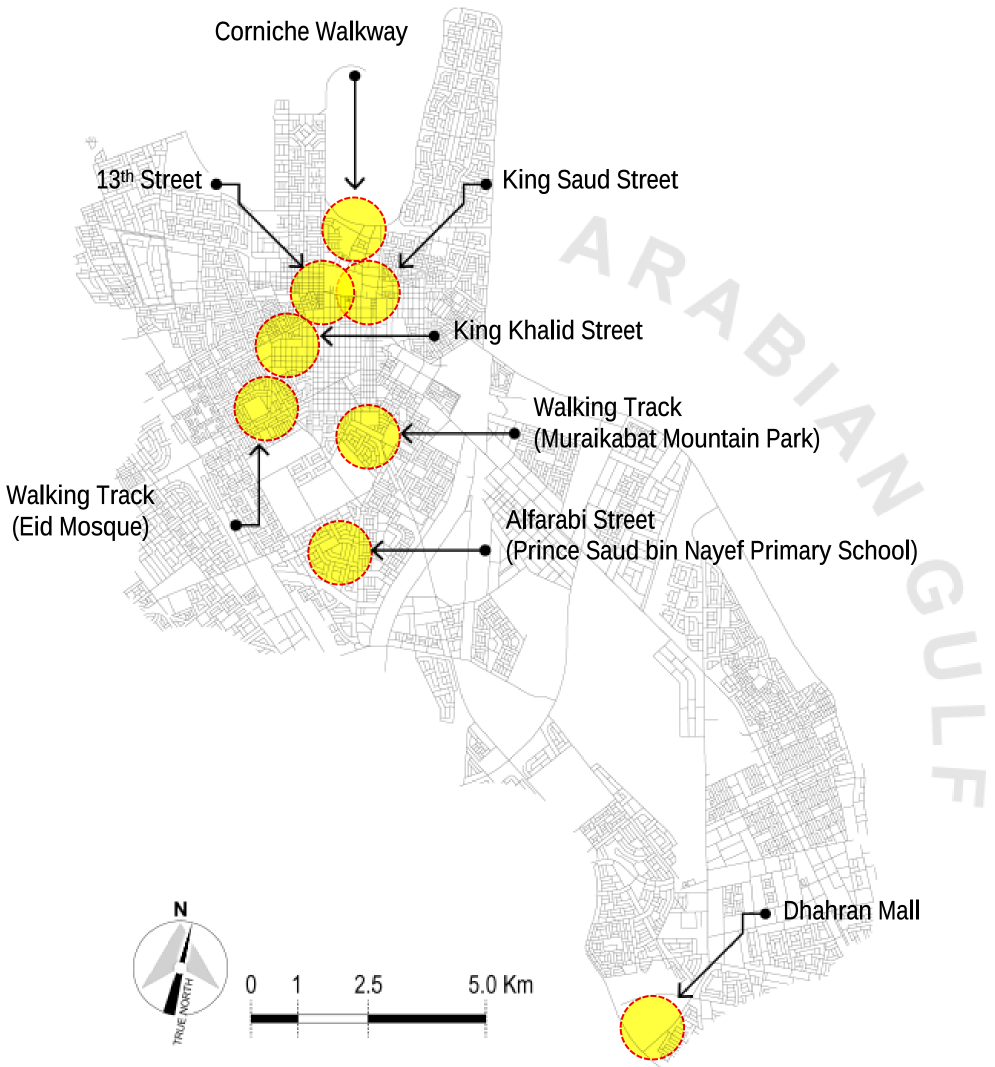

Figure 5.10 Locations of data collection sites

Table 5-2 Background information for each data collection site

Site		Method Used	Brief Description	General View *
(1)	The Eid Mosque walking track	• Structured Interviews with Standard Questionnaires	• Total distance: 1.2Km • Circular walkway • The first constructed standalone walking track • Character: residential	
(2)	The Muraikbat walking track		• Total distance: 1.6Km • Linear-shaped walkway • Total area ≈ 68,400m² • Surrounds a park with rocky outcrops • Character: residential	
(3)	Dammam Corniche walkway		• One segment (1.2Km) of a long walkway (+7Km) • Located between two roundabouts • Character: recreational area surrounded by seawater & major arterial roads	
(4)	King Khalid St.		• One segment = 220m • One side was covered • The street received widening & regeneration processes • Character: residential & commercial	
(5)	King Saud St.	• Structured Interviews with Standard Questionnaires • Participant Observation	• E-W oriented • The first road built to separate between the old fabric & first Gridiron plan • One segment = 315m long • both sides were covered • Character: residential & commercial	
(6)	13th St.		• N-S oriented • Total distance = 370m • Both sides were covered • Character: female-oriented commercial activities • The street experienced several pedestrianisation attempts, in the past	
(7)	Dhahran Mall	• Structured Interviews with Standard Questionnaires	• 2-3Km ring corridor • Free parking • Various activities (recreational, commercial, public services) • Surrounded by vacant lands	
(8)	Alfarabi St. (Primary School)		• One segment = 250m long • One side was covered • Character: educational & residential • Only primary school pupils (6th GR.) were covered	

A. Observation sites:

Drawing on the findings of the pilot observation, coupled with necessity to observe realistically the actual use of existing streets, the participant observation was limited to two selected streets in the city centre (King Saud street and 13th street). Although the researcher was aware that the commercial character of the buildings and activities surrounding both streets could have had some influence on the pedestrians' experience, including where they were walking, standing or sitting, the researcher was compelled to rely on these streets, for the following reasons:

a) The city centre is the most compact urban structure of Dammam used by all ethnic groups and sexes;

b) It is the oldest part of the city which has always received special attention since the city was built;

c) It is the first area of the city that has witnessed major physical and spatial regeneration processes, since 2009 (see section 4.4.4.1); and

d) The selected streets were the best suited sites where street life and pedestrian movement and activities could be observed successfully, as well as the impact of their orientation on providing outdoor thermally comfort conditions could be compared or evaluated, and hence can contribute to produce promising results.

Since the selection of streets was defined, the selection of a particular segment for observation within each street was fundamental to be predefined (Figure 5.11). This was attributed to the limited resources to the researcher (time, budget and number of assistants), as well as considering the length of each selected street, thus, physically impossible to cover the whole site. The key criterion for selecting the segment was based on evaluating the most used part in each street, where it was as far as possible a representative setting to all possible activities and behaviours of pedestrians.

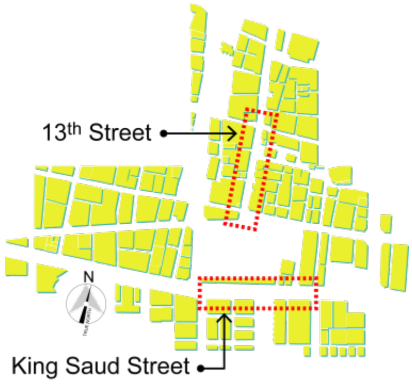

Figure 5.11 Locations of the observation segments within the selected streets

Moreover, while the observation was carried out in these two selected streets in the city centre, the application of the questionnaire was conducted in all selected sites, including these two streets. However, the questionnaire was carried out after the observation activities[56].

B. Interview sites:

Carrying out the interviews both on and out of the street space was not only because of the observed lack of pedestrians on streets, but also due to the influential role of the immediate interaction of the participants with the surrounding environment; physically, spatially, thermally and visually. Participants were able to link the relevant questions to their natural setting. Hence, identifying any design attributes they preferred for fostering their willingness to restore their walks into the street space would be more realistic and reflective. Eventually, a blueprint for improving the street environment for walking could be attained.

Several researchers have demonstrated how reliable and fruitful collecting the required data, from the actual users in their actual settings, can be in providing quick, spontaneous and candid answers to questions pertinent to their immediate surroundings, or even to different sites, so long as the phenomenon under study is the same (e.g. Zeisel, 2006; Gehl & Svarre, 2013; Molnar, 2015). On the other hand, Dhahran Mall, although it is an indoor environment situated outside Dammam's boundaries (Figure 5.10), was selected for its popularity to attract people interested in walking. The primary purpose of this selection was only to explore any similarities and differences, which its users highlighted.

5.8.3 Fieldwork assistance

It is often observed that researchers conducting outdoor studies which involve a direct interaction with the public need to seek help from external sources. One of the advantages of having an assistance team that is not part of the research is to enhance unbiased collection of the data. These, coupled with the need to maintain a consistent

[56] The reason for this was the need of the researcher to avoid being exposed too early to frequent users of the selected streets.

and positive attitude while collecting both the required data and samples, the field study involved co-opting some assistants with the researcher.

This procedure was essential, since the researcher neither had any control over the selected sites, in terms of their open nature and hence the difficulty in obtaining a representative sample, nor over the pedestrians, particularly at weekends, together with the need to ensure gathering a sufficient sample size that included all community layers; thus, the researcher was assisted by nine volunteers and a female assistant (Figure 5.12). While the volunteers were landscape architecture graduates, the female assistant, whose help was sought occasionally, was a family member of the researcher with an architectural background.

Owing to the fact that male-female interaction, and hence interviews, is a very sensitive issue to the Saudi context, as discussed in Chapter Four (section 4.3.2), the presence of the female assistant was inevitably necessary, to enable sufficient questionnaires to be gathered from the female group. Without such assistance, it may have been virtually impossible to include women in this research. This is another aspect which contributed in making the methodological approach for collecting data in this research innovative, in that it is rarely (or even never) observed that women are included in outdoor-related studies in Saudi Arabia.

Figure 5.12 Some of the fieldwork assistants during interviews

The fieldwork team was divided into three groups, three in each one, and carried out the data collection process together in the same site, at the same time, for the following reasons:

a) To ensure the method was implemented correctly and data were successfully collected under the direct supervision and guidance of the researcher;

b) To facilitate the researcher's intervention when more clarification was needed, or even to show the official permits to carry out the field study (see section 5.8.5 & Appendix B); and

c) To formalise the process, as a result of the presence of a relatively large number of the assistants in one place, and hence give credibility of the field study to the participants, as one of the socio-cultural concerns.

5.8.4 Limitations of the fieldwork

a) Outdoor thermal comfort

The use of the PET index, as analytical method for identifying thermal comfort, was only applied to the questionnaire, whereas it was excluded from the participant observation. The reason for this was the lack of subjective evaluation of the thermal environment. That is, any measured microclimate data would be meaningless, to estimate the pedestrians' thermal comfort, unless rating of thermal sensation by the pedestrians had been measured, and thus compared to the actual environmental readings. However, the four microclimatic factors were recorded, during the observations, for descriptive purposes.

b) Sample size

For the interview-based questionnaire, it has been argued that researchers working outdoors, in a field study and without assistance, are advised not to expect "more than around 200 survey interviews in a year" (Bernard, 2006: 257). However, a sample size of ≥ 30 participants was adopted as the minimum targeted number, to be obtained from each site in this research, as this was recognised quite sufficient to run SPSS to produce valid data and reliable results (Kremelberg, 2011; Sahu, 2013).

Accordingly, 260 questionnaires were presented to the pedestrians in the eight selected sites. The total number of valid questionnaires, or successfully interviewed participants, was 244. The 16 unreturned forms were a result of passive participants, who requested some time to read it first and decide whether to take part or withdraw.

For the participant observation, the purposefully qualitative nature of this method does not lend itself to quantification; therefore, there was not a targeted number to be fulfilled. Rather, the focus of attention was on the required information to be collected from as many pedestrians as the observation required. However, for a descriptive purpose, a total of 198 pedestrians were observed, for both sites.

c) Including children in the study

As stated above, there was an obvious lack of children at primary education level observed to be walking during the pilot observation (section 5.8.1). Therefore, it was essential to follow a different approach to interview this group, in order to specify the underlying factors behind their reluctance towards walking. Including this group was considered central for the research to be holistic, by including all community layers, so that any proposed design interventions would become compatible and convenient for all. Indeed, the incorporation of children was another contributing factor in making the data collection process in this research innovative.

Accordingly, the researcher made an arrangement with Prince Saud bin Nayef Primary School to interview this segment (see Appendix C.1). The selection of this school was due to its location on a recently regenerated street (Alfarabi Street), the flexibility of its curriculum and the reputation of the school[57] in participating in several social studies. However, in order to avoid any ethical issues related to the involvement of minors in research, including being photographed, obtaining in advance parental permission was essential.

Thus, before the school sent the consent letter for parents, a preliminary draft by the researcher had been prepared. The purpose was to provide parents with a clear background to the study, what sort of information would be sought from their children and how the collected data would be processed. The final version was then reviewed and agreed upon with the head teacher, in order to follow the official format when contacting parents (Appendix C.2)[58].

Subsequently, and before the actual process took place, a group of sixth grade pupils (n=33) went through a short training session inside the school. Following such an approach was an effective mechanism (a) to get them used to the method, especially

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[57] Visiting the school was a great learning opportunity/experience for pupils to get to know how data collection methods are scientifically conducted and to increase their awareness about consequences of the decline in walking, as well as to briefly introduce them to Landscape Architecture.

[58] A translated English copy of the original parental consent letter is included under Appendix C.3.

as this age group had never experienced such a method before, and (b) the intention to reduce the time required to fill in the questionnaire during the actual process. This activity was divided into two periods and took a total of one hour and 45 minutes, including 15-minute break.

During the first half, the selected pupils were introduced to the basic concepts of the questionnaire method, provided with the purpose behind collecting the required data and given an explanation of how to deal with the form (Figure 5.13/A). In the second half, they were given a simplified version of the final draft (ten questions), as if it was the real survey, without letting them know it was just an exercise (Figure 5.13/B).

A. 1st Half: introductory session (45 minutes) B. 2nd Half: training session (45 minutes)

Figure 5.13 A training session about the questionnaire method was given to 6th grade pupils, in order to be included in the study

This latter approach was a very sensitive procedure, in that they thought that collecting the required data had been completed just by filling in this miniature version. This manipulation was carried out with the aim to avoid any issues related to validity and reliability of answers, in the actual data collection process in the street space. Two weeks later, in coordination with the school, to interview the selected pupils during one of the scheduled outdoor visits, the actual process was conducted without pupils' prior knowledge of this arrangement.

Collecting data was carried out on the adjacent street (Alfarabi) by taking the pupils out for 15-minute walk, and then they were asked to fill in the questionnaire according to the experience which they had just completed.

5.8.5 Ethical considerations

According to Gehl and Svarre (2013: 6), when gathering data on outdoor users of urban spaces, including their behaviours, activities and preferences, "it is always important to weigh how and where ethical considerations should be made". Similarly, researchers studying public life in a field study, particularly when their studies might involve violating an individual's privacy, should always maintain an ethical dimension and professional obligation to be moral. This holds true even when subjects under study are unaware of, or unconcerned about ethics (Miles et al., 2014; Neuman, 2014; Shaughnessy et al., 2015).

Thus, the issue of values, or ethical concerns, is often addressed differently according to the research topic and researchers themselves. However, legislations play an important role in this context, and typically vary from country to another, as a result of the direct impact of certain socio-cultural attributes, or codes of ethics. For the present study, this was a crucial stage, as it could contribute to the success or failure of the entire field study. For example, taking photos or making video recordings of public spaces and people, in the Saudi context, is an extremely sensitive issue.

Accordingly, it was fundamental to obtain the required permits (see Appendix B), prior to conducting the actual field study, in order to: (a) avoid any ethical and socio-cultural concerns, including any real invasion of privacy, as well as any legal liability; and (b) assure the participants that their information would be treated in a proper manner; remaining anonymous and confidential, for research purposes only.

Therefore, the necessary permits obtained were: (a) an authorisation letter from the supreme government body in Dammam; the Emirate of the Eastern Province, addressed to the concerned authorities; (b) a permit for indoor and outdoor photography, issued by the Ministry of Culture and Information; (c) a permit for collecting data indoors, issued by the selected shopping mall; and (d) a letter of parental consent for their children to participate in the questionnaire, issued by the selected school.

5.9 Summary

This chapter has presented the case study method as the overall methodological framework used in this research. This method of research is favoured when the focus of study is a contemporary phenomenon, and when an existing theory fails to adequately explain underlying factors behind the occurrence of the phenomenon. Dammam is the case study, and the reliance on this method was to attain a deeper understanding of the relationships between the pedestrians' withdrawal from the street space to other urban spaces, for walking, and the context encompassing this phenomenon (urban streets). It was also selected because the boundaries between this phenomenon and street design are not clearly evident.

Within the framework of the case study research, the strategy of a mixed-method approach, combining participant observation with an interview-based questionnaire, was carried out in a field study, to collect the required data to answer the key research question. Following this approach has been found to be fruitful when first-hand knowledge of the phenomenon is desired, especially when little data exists or lack of precedent studies. Both techniques were considered the most appropriate and compatible for the Saudi context, as well as likely to be productive and promising to fulfil the research aim.

The interviews were the main data collection technique, owing to the requirement for subjective evaluation in assessing simultaneously the impact of the three proposed components on their reluctance towards walking on streets. However, the observations were supportive in increasing comparability of the data, and hence helped in answering questions that the interview could not measure. Therefore, the research findings were of a mixed nature, both descriptive and statistical, so as to provide more reliable explanations that could lead to revealing the cause-and-effect relationship between street design and walking.

Moreover, it has been acknowledged that, if the same phenomenon is studied and the data collection is obtained from a few cases rather than many cases, this can contribute to gaining rich insights into the phenomenon and unfold the latent aspects associated with the research problem. Accordingly, from the four available walking places in Dammam, eight sites were selected for the field study, in which both data collection techniques were applied. Interviewing and observing the pedestrians in their actual walking places, under the influence of the immediate conditions, were a contributing strategy to ensure collecting the required data in a quick, spontaneous and candid way.

The next chapter will present the data collected from the field study, and highlight any unexpected/surprising findings arising from both the quantitative and qualitative analyses. It also will identify the weight of each component of the proposed tripartite conceptual model and provide evidence regarding what characteristics of street design worked for or against the pedestrians in their intention to walk.

Chapter Six: Analysis and Findings

“An important finding from experimental studies is the identification of factors which have significant influence” (Parsons, 2014: 12)

6.1 Introduction

The previous chapter introduced and described, in detail, the most pertinent aspects of the two data collection methods employed in this research: interview-based questionnaire and participant observation, both of which were carried out in a field study in Dammam. It also delineated any organisational issues and procedures associated with carrying out this process.

This chapter presents the findings that emerged by analysing and interpreting the collected data through these two methods. However, it is important to restate here that the questionnaire was the major data collection technique to answer the main research question. This is due to the need for a subjective evaluation of the impact of the three factors of the proposed conceptual model, simultaneously and collectively, on the pedestrians’ reluctance towards walking on streets.

However, the participant observation serves as a supporting method, with a particular aim: to better understand the actual use of the street space by the pedestrians. Thus, the findings of this method can reveal any significant differences or similarities with the major findings of the questionnaire, and hence ensure the validity and reliability of all the findings. Therefore, the findings presented in this chapter are of a mixed nature of descriptive (narrative) and statistical (numeric), so as to provide more reliable explanations that may reveal the cause-and-effect relationship between street design and walking, which can eventually contribute to restore the pedestrians into the street space.

Accordingly, this chapter is divided into two sections, where each one focuses on the findings of one method. Hence, the questionnaire is presented first, and begins with a descriptive analysis showing the preliminary findings, followed by in-depth analytical results of the relationships between the variables measured.

6.2 Structured interviews with standard questionnaires

The ultimate purpose of the questionnaire was to identify the weight of each component of the tripartite model proposed by this research (Figure 1.12). This can be achieved by identifying the latent variables that may have a greater explanatory power than others pertaining to the pedestrians' reluctance for using the existing street space, with its existing conditions, for walking.

Accordingly, the first step, in this section, is to present descriptive statistics through frequencies of the participants' responses to each variable in the questionnaire; thus, providing an overall view of their perceptions and preferences, or even obstacles hindering street use for walking. The second step is to investigate the causal relationships between one or more variables with other variables, and hence to report any inferential statistics through use of analytical tools in SPSS. It is worth mentioning, that although, initially, the questions were individually presented and structured in a different order in the questionnaire, it was considered very helpful to combine some pertinent elements together when reporting the findings in this chapter.

6.2.1 Descriptive analysis

The questionnaire consists of 55 questions that load onto three parts, representing the tripartite relationship proposed by this research, plus a fourth part covering the demographic data of the participants. This section presents the preliminary findings of all these questions, encompassed within these four parts, in addition to the microclimatic conditions recorded simultaneously during each interview.

The total number of valid questionnaires collected from the eight selected sites was 244 (n=244). The number of participants in five of the sites was 30 (n=30); however, it slightly differed in the remaining three: King Khalid Street (n=37), Alfarabi Street (Primary School) (n=33) and 13th Street (n=24). Subsequently, all forms were arranged, by site, and data were coded for statistical processes and analyses. It is worth mentioning that Microsoft Excel was always used for the final presentation of the generated results from SPSS.

6.2.1.1 Findings of measuring the microclimatic conditions

The urban microclimatic conditions were recorded during each interview, for later analysis, by correlating these readings with the thermal perceptions of the participating pedestrians. This was carried out with the aim to identify the upper thermal comfort limit, for pedestrians, and hence define the acceptable thermal conditions in outdoor spaces of Dammam.

Table 6-1 below summarises the measured four microclimatic variables, in addition to the calculated PET index and Tmrt. What is interesting to be note in the table is that the mean values of the measured Ta, Tg, RH and v were slightly biased toward the minimum values. This may be attributed to the fact that most of the interviews were carried out in late afternoon, under shaded or cloudy conditions, where the thermal conditions were relatively low compared to sunny conditions.

Table 6-1 Descriptive statistics of the overall microclimatic data during the interviews

Parameters	Min	Max	Mean	St. Dev.
Measured Air Temperature – *Ta (°C)*	25	45	34.75	6.523
Measured Globe Temperature – *Tg (°C)*	26	46	35.82	6.602
Measured Relative Humidity – *RH (%)*	11	70	37.47	17.541
Measured Wind Velocity – v *(m/s)*	0	7	3.38	2.053
Calculated Mean Radiant Temperature – *Tmrt (°C)**	28	49	38.88	7.234
Estimated Physiological Equivalent Temperature – *PET (°C)***	22	50	36.29	9.158

* *The Tmrt was calculated through Equation 2 presented in Chapter Three (section 3.3.7–B)*
** *The PET index was calculated by using the RayMan Software (version 2.1)*

By contrast, the mean values of the Tmrt and PET were slightly biased toward the maximum values[59]. This state may be attributed to the influence of the phenomenon of the Urban Heat Island (UHI)[60] that begins to increase late afternoon (before the sunset) and reaches its maximum during the night, which is the same period of the field study. Bearing in mind the lack of shading methods, during the period of the interviews, the stored heat, as a result of the thermal properties of urban surfaces and materials, was transferred back to the surrounding atmosphere, by convection, in the

[59] It has been acknowledged that the Tmrt can be several degrees higher than the air temperature in outdoor settings as a result of direct and reflected radiations from surrounding surfaces and atmosphere (Mayer & Höppe, 1987; Gulyás et al., 2006; Lin et al., 2010; Tan et al., 2013).
[60] This is the phenomenon of excessive warmth, or increased air temperature, near and above the ground in urban areas compared to non-urbanised or rural areas (Oke, 2002; Gartland, 2008; Rizwan et al., 2008; Alznafer, 2014). See Chapter Three (section 3.3.8) for more details.

form of sensible and latent heat fluxes, and hence affecting both the Tmrt and PET values.

6.2.1.2 Findings of PART I: profile of the participants

(1) Gender and Ethnicity (Q. 1 & 2)

The first part of the questionnaire covers the general data of the participants including their gender, ethnic group, age group, physical characteristics and activities. Figure 6.1 shows that majority of the participants were males and Arabs; 70.1% and 67.2% respectively, whereas the female group and the non-Arabs were a minority in the sample, 29.9% and 32.8%, respectively.

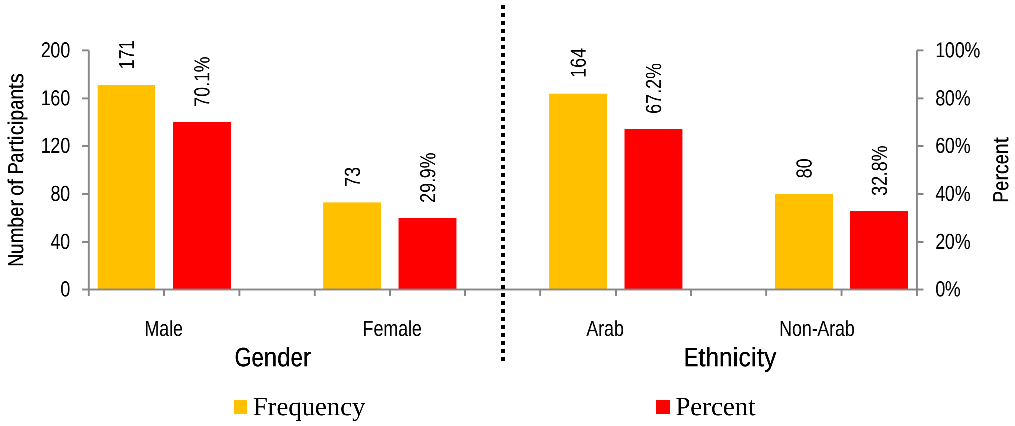


Figure 6.1 Distribution of the participants by gender and ethnicity (Q. 1 & 2)

According to the CDSI (2014), the total population of the Kingdom, in 2012, was 29.2 million. The Arab population represented 19.8 million (67.95%) and the non-Arabs constituted 9.4 million (32.05%). Thus, it can be said that the proportion of the sample collected, in this research is relatively close to the national statistics. However, the total population in Dammam (ibid.), for the same year, was almost 976 thousand, where the Arabs occupied nearly 582 thousand (59.63%) and non-Arabs were exactly 394 thousand (40.37%).

Regarding females, the total number, in 2012, was 12.7 million (43.34%) and the male population comprised 16.5 million (56.66%). In fact, the big gap in the total number between male and female participants, among the collected sample, may be attributed to three possible interpretations:

a) Males may have more necessary outdoor walking purposes than females, or they simply were more interested in strolling outdoors than females;

b) The male group may have much stronger considerations toward walking than females, or females may hold certain reservations or concerns making them feel uncomfortable walking outdoors. However, the researcher believes that the reason may be strongly attributed to;

c) The impact of the male-female interviews, as one of the most sensitive socio-cultural restrictions as discussed in Chapter Four (section 4.3.2), because women were observed, by the naked eye, to be the majority of pedestrians, particularly along the walking tracks and Corniche walkway.

It is necessary, therefore, to pay a careful attention to the females' requirements, including any concerns and considerations towards walking in outdoor spaces.

(2) Age groups (Q. 3)

Figure 6.2 shows that the participants aged ≤ 40-year old represented over two-thirds (71.8%) of the total sample, whereas those who were > 40-year constituted only 28.2%. The national statistics, for the same year in which this research's data was collected, showed that the age groups ≤ 40-year old constituted 78.84% of the total population, and the age groups > 40-year were 21.16%. Therefore, it can be said that the proportion of the research sample was relatively close to the official national statistics, for both these age groups. Table 6-2 compares, in detail, the research sample and the national statistics, by each age group.

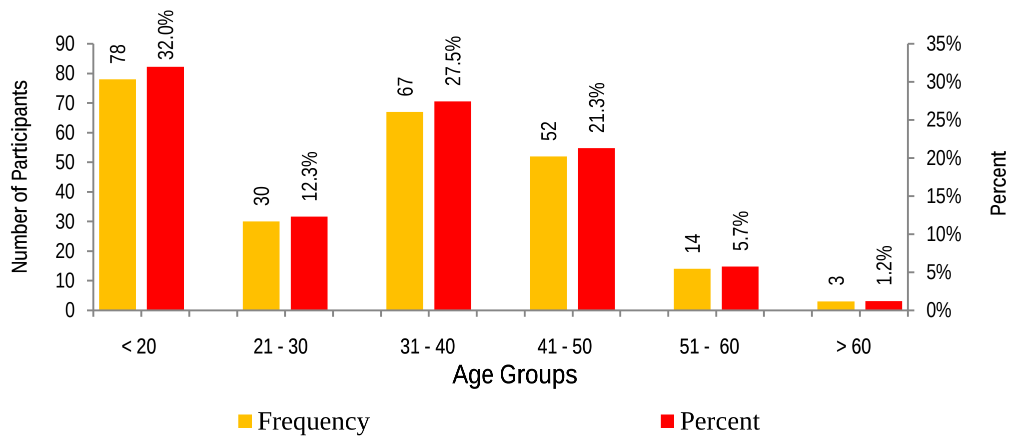


Figure 6.2 Distribution of the participants, by age group (Q. 3)

What can be interpreted from the table below is that there was a disproportionate distribution of age groups for participants younger and older than 40. This may be attributed to the growing interest among young groups towards outdoor walking. However, the participants older than 40 were interviewed more frequently on the selected streets in the city centre than younger groups, who seemed more interested for walking in the walking tracks and along the Corniche area.

Table 6-2 Comparison of age groups between the official statistics and the research sample, in 2012

Age Groups	Official National Statistics – 2012 (%)	Research Sample – 2012 (%)
< 20	41.65%	32.0%
21 – 30	18.55%	12.3%
31 – 40	18.64%	27.5%
41 – 50	11.27%	21.3%
51 – 60	5.59%	5.7%
> 60	4.30%	1.2%

(3) Place of residence

When verbally asking the participants about their place of residence[61] (nearby or distant from the site in which they were interviewed), nearly 81% indicated they lived far away, whereas only 19% stated that they were living within the adjacent neighbourhoods (Figure 6.3). It is evident that there is a tendency among the pedestrians to travel any distance to a certain destination for walking. This may be attributed to (a) some of the socio-cultural aspects, such as to avoid being seen by others, as highlighted in Chapter Four (section 4.3.1), (b) deficiency of the street space to meet the participants' expectations, or (c) walking is simply perceived as a recreational activity.

[61] This was not a written item in the questionnaire, but intentionally was kept to the end of the interview due to socio-cultural concerns, and then answers were coded on each form.

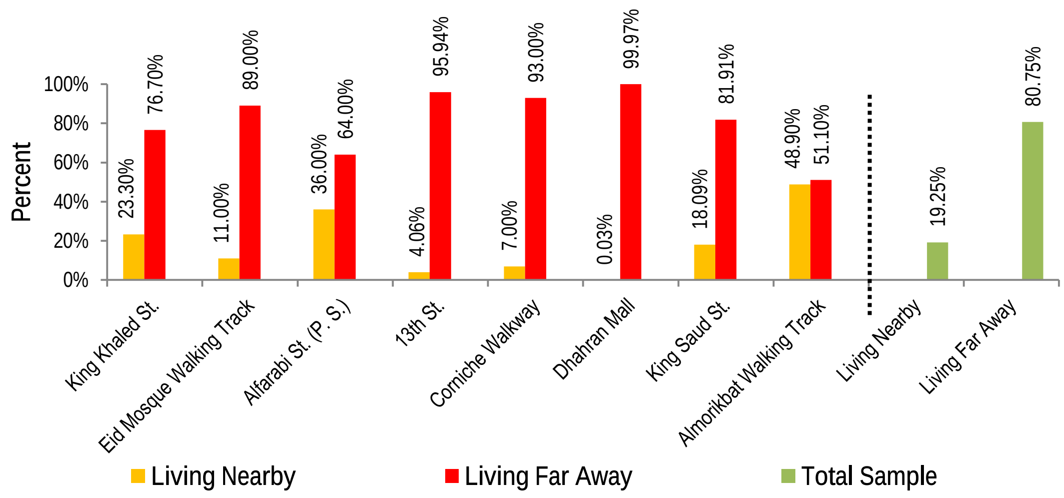


Figure 6.3 Distribution of the participants' place of residence by case-study area

(4) Participants' physical characteristics (heights & weights) (Q. 4 & 5)

Originally, this question was mainly included in the questionnaire as a prerequisite for calculating the PET. However, the same data were also used to calculate the BMI for comparison purposes, because the BMI has been widely used as an important social indicator characterising the lifestyle of communities.

a) ***Heights:*** Figure 6.4 shows that almost 46% of the participants fell within the height group of 1.61-1.70m, whereas 29.1% and 9.0% were in the height groups of 1.51-1.60 and ≥1.71m, respectively. Thus, 75% of all participants ranged between 1.51 and 1.70m tall.

b) ***Weights:*** The same figure reveals a normal distribution of weight groups among all participants, with an average weight of 68.6kg for the total sample. However, weights of the majority were ranged between 61 to 80kg (42.2%), followed by 15.2% and 15.6% of the participants falling within the groups of 51-60Kg and 81-90Kg, respectively.

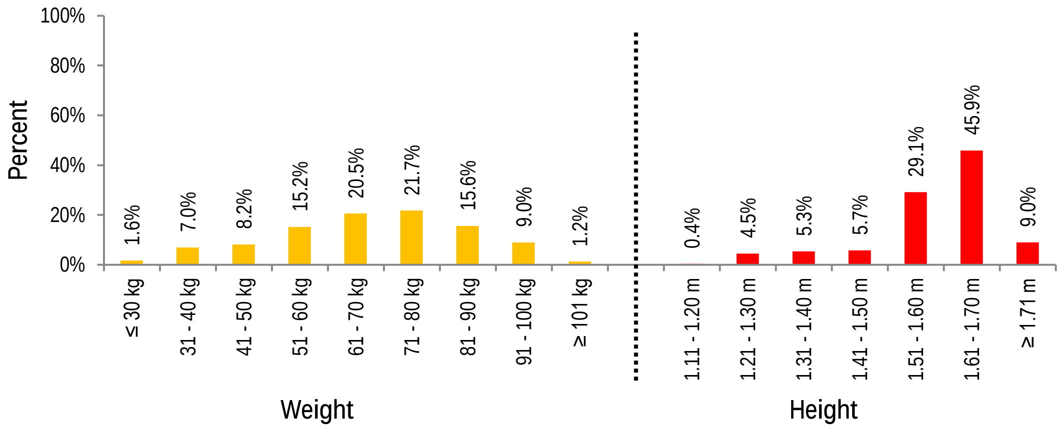


Figure 6.4 Distribution of the participants' weight & height measurements (Q. 4 & 5)

c) ***Body Mass Index (BMI):*** By obtaining the participants' heights and weights, an estimation of the BMI can be calculated through Equation 3 below. The BMI represents a measure of an individual's body fat based on weight divided by the square of the height, with the value being given in units of kg/m^2, which applies to all ages and genders.

BMI = Weight (kg) ÷ (Height (m) x Height (m)) **Equation 3**

Presenting the results of the BMI values here is very important to provide more recent data than those described in Chapter One (section 1.5.4–1). The underlying purpose is to discover any correlations between pedestrians' motivation to walk for health reasons and their actual body size.

The levels of being overweight and obesity are based on the international standards, where a BMI value between 25.00 and 29.99kg/m^2 represents being overweight and a BMI value ≥ 30.00kg/m^2 indicates obesity. The calculations showed that just above 22% of the sample was obese, while nearly 41% of the participants were overweight (Figure 6.5).

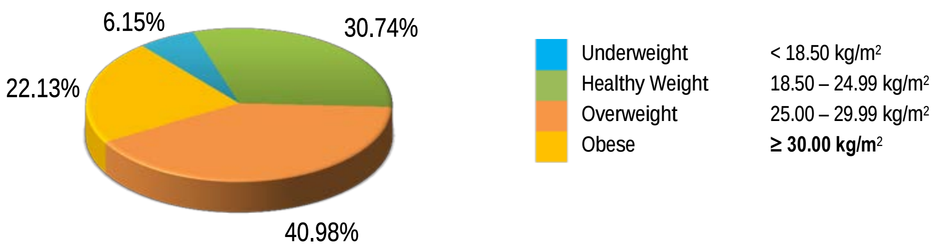


Figure 6.5 Frequency of the BMI groups among the research sample

Figure 6.6 shows that 27.5% (n=67) of the total participants indicated that their purpose for walking was due to health reasons. Among this segment, 52.2% were obese, and 28.4% overweight, while only 16.4% were of a healthy weight and 3% underweight, or 14.3%, 7.8%, 4.5% and 0.8% out of the total sample, respectively.

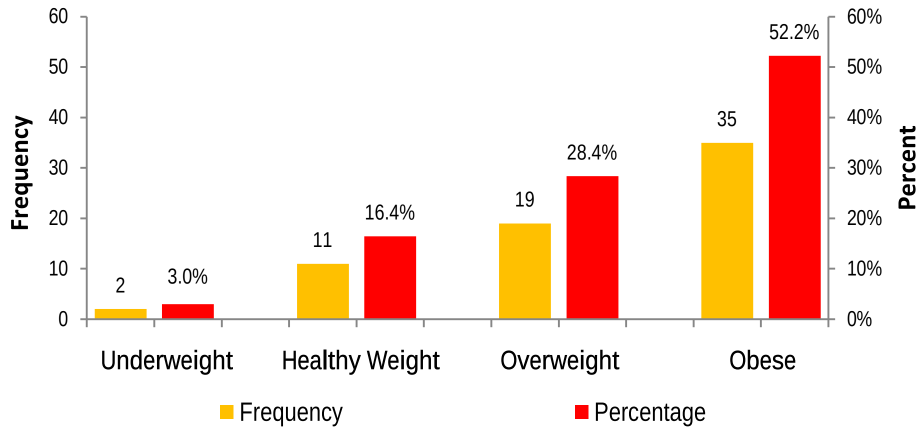


Figure 6.6 Distribution of the BMI among the participants who were walking for health only

What is really important to document here is the great proximity in the average BMI value between the research sample and the WHO data (1980-2009). The female group consistently appears to record higher overweight rates than males in both data sets (Figure 6.7), which also has been confirmed by Dawoud et al. (2011). This can be interpreted as suggesting that women may have less opportunities and accessibility for physical activities on a regular basis, especially outdoors.

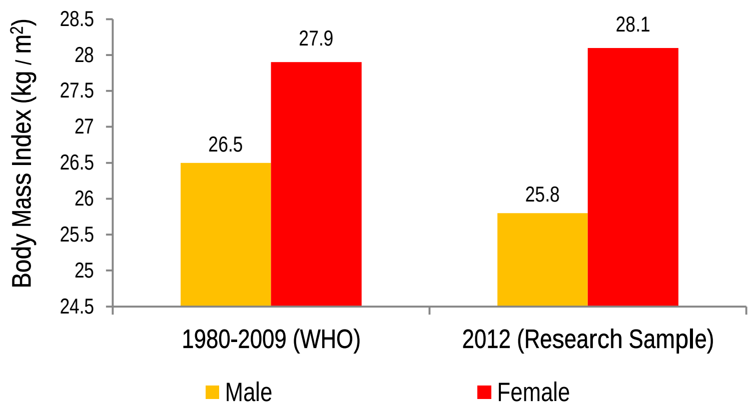


Figure 6.7 Comparison of the average BMI value (kg/m^2) between the WHO data (for a 30-year period) and the research sample, by gender

(5) Previous activities (Met) (Q. 6)

Although the main focus of the questionnaire was on walking pedestrians, a very limited number of participants were other types of street users (sitting, selling, standing or jogging). Figure 6.8 shows that walking pedestrians accounted for the majority of the sample (87.3% (n=213)).

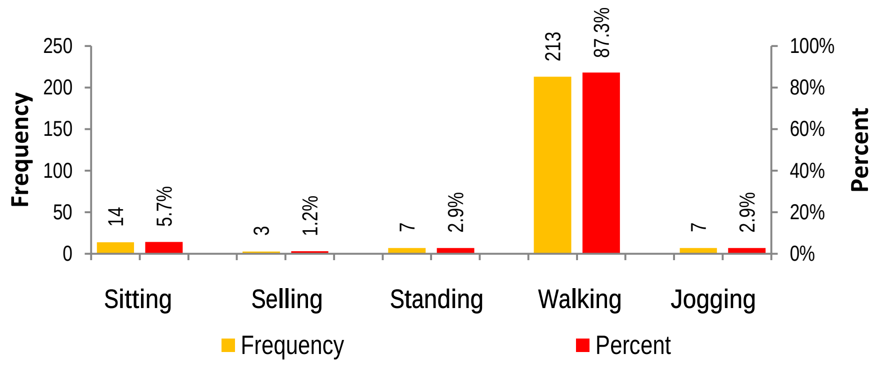


Figure 6.8 Participants' activities within the last 15 minutes prior to the interview (Q. 6)

This question represents the fifth required factor to estimate the PET. Hence, the participants' answers were confined to the last 15 minutes before the interview, as recommended by ASHRAE (2004). The underlying purpose of this limitation is due to the impact of metabolic rates generated by the physical activity practised on their thermal sensation within this period, and thus more realistic estimates for the thermal comfort. Appendix D.3 lists the ASHRAE standard for various activities and the equivalent metabolic values adopted in this research.

(6) Previous environment (Q. 8)

Similarly to the previous question, the participants were asked to identify where they had been during the last 15 minutes prior to the interview. Figure 6.9 shows that about 4/5 (82.8%) of the total participants reported that they were in outdoor spaces within this period. Again, this is important information to estimate a more realistic picture of the pedestrians' thermal comfort, where the human body needs around 15 minutes to adapt to a new environment. For comparison, 17.2% of the participants were indoors (e.g. in mosques, houses, grocery shops) within this period.

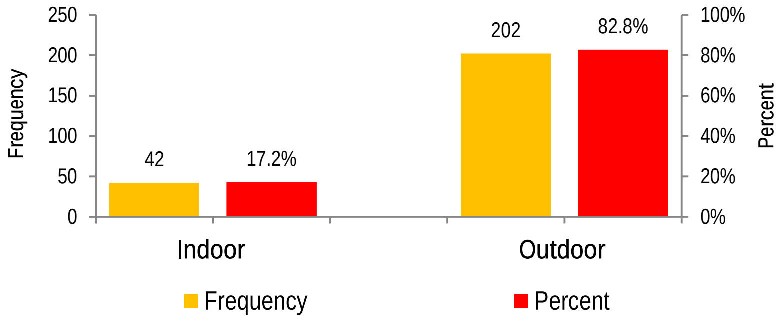


Figure 6.9 Participants' previous environment within the last 15 minutes prior to the interview

(7) Clothing levels (clo) (Q. 9)

This is the sixth prerequisite factor for the calculation of the PET values. In order to maintain consistency, and to avoid any feeling of discomfort by the participants, particularly women, the clothing insulation values (clo) of each participant were estimated by the researcher. While the participants were answering the questionnaire, the researcher was taking notes of this factor. Subsequently, the sum of the insulation values of individual garments was calculated, based on data from three sources.

For the participants who were wearing western-style garments, two lists of clothing insulation values were adopted from McCullough et al. (1984) and ASHRAE (2009) (Appendix D.1). For the participants who were wearing traditional Gulf clothing, the required list was adopted from Al-Ajmi et al. (2008) for males and females (Appendix D.2). Accordingly, Figure 6.10 shows that nearly 55% of the total participants were wearing clothes with insulation resistance values ranging between 0.41 and 0.60 clo, followed by 28.7% who were wearing clothing levels with resistance values ≥ 1.0 clo. This latter frequency is considered relatively high, but it may be attributed to the impact of female clothing levels that cover the entire body. However, the average clothing insulation value was 0.76 clo.

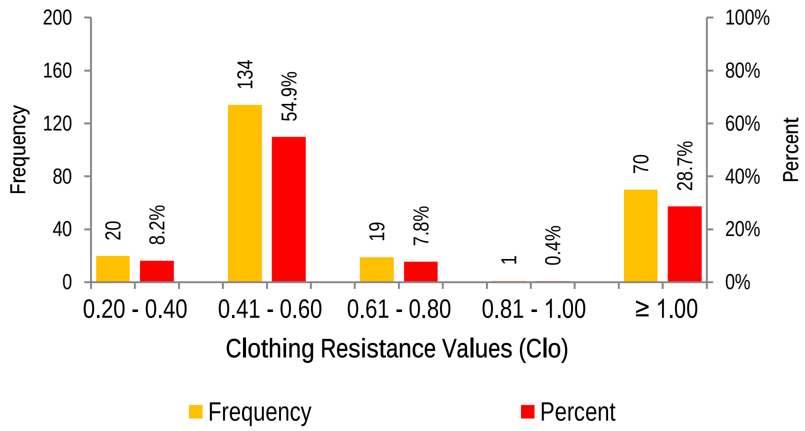


Figure 6.10 Distribution of participants according to their clothing level values (clo) (Q. 9)

(8) Car use and number of cars (Q. 11 & 12)

When asked whether or not they go to any walking place by car, even with help from someone else like a family member, mainly for women, 86% of the sample reported their dependence on cars. Only a small group (14%) reported that their activity was usually accomplished without the car use (Figure 6.11). These percentages are relatively very close to those for the participants who indicated that their place of residence were close vs. far away (see point (3) above). However, in terms of male-female differences, the female group recorded a higher score (94.5%) for relying on cars to reach a walking destination, compared to males (82.5%).

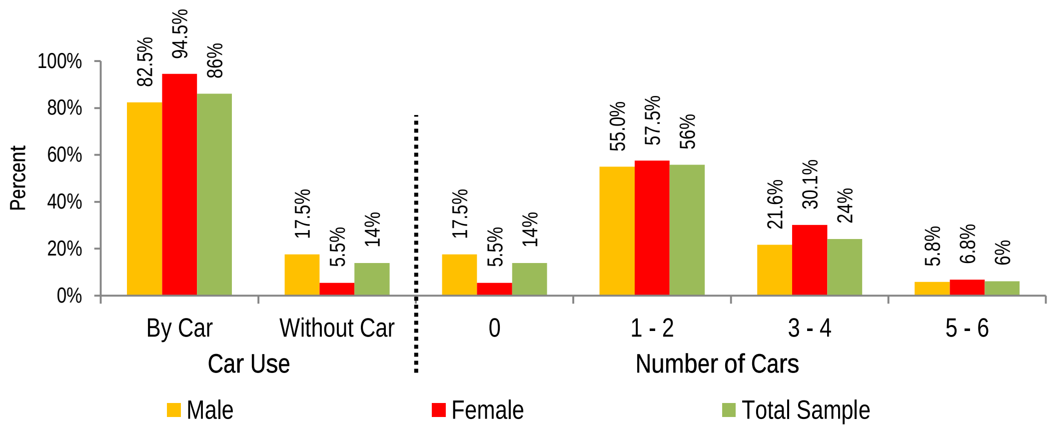


Figure 6.11 Distribution of participants' vote to the car use to reach a walking place, and number of available cars in the house (Q. 11 & 12)

Moreover, 86% of the participants confirmed the possession of one car or more, although the majority (56%) owned 1-2 cars followed by 24% who had 3-4 cars available. What is interesting to highlight here is that the participants who did not own a car (14%) were the same group (14%) who typically go to walk without the car. For a descriptive purpose, this entire segment comprised non-Saudis[62], including females living nearby, and was exclusively using walking tracks.

Surprisingly, 94.5% of females own one car or more compared to 82.4% of the male participants. It is worth mentioning here that despite the fact that women have not yet been allowed to drive in Saudi Arabia, they are permitted to own cars and hire someone for driving. What can be explicitly deduced from such information reflects the complete dependence of pedestrians on cars, on one hand, and their tendency to travel any distance for walking, on the other hand. Even more, these ratios emphasise that pedestrians have become more attracted to other urban places than streets. This can be either interpreted as walking being perceived as a leisure activity, or simply that streets have failed to sustain the pedestrians' requirements.

6.2.1.3 Findings of PART II: measuring outdoor thermal comfort

The second part of the questionnaire focused on measuring the thermal sensation and preference of the pedestrians regarding the ambient microclimatic conditions, at the time of the interviews. This section was compulsory, to enable the researcher to carry out the subsequent analysis, to identify the microclimate conditions at which the pedestrians feel thermally comfortable and beyond which they would feel uncomfortable, and thus defining the upper thermal comfort limit. It also describes the participants' frequency of walking during temperate conditions.

(1) Thermal sensation (Q. 13)

Although the thermal sensation vote was measured using the 7-point scale, no one voted below the neutral sensation, specifically, *slightly cool*, *cool* or *cold*, and hence these three scales were omitted from the analysis. This is explicitly owing to the fact that the interviews were conducted during spring; where the weather conditions are typically observed to become warm in Dammam. Therefore, 27.9% of the participants indicated that they were feeling very hot, though, slightly over one-third (38.1%) expressed their acceptance (neutral feeling) of their surrounding thermal

[62] This is based on the participants' answer to Q. 2.

conditions (Figure 6.12). The results also showed nearly equal proportions voted for warm and hot; 17.2% and 16.8%, respectively.

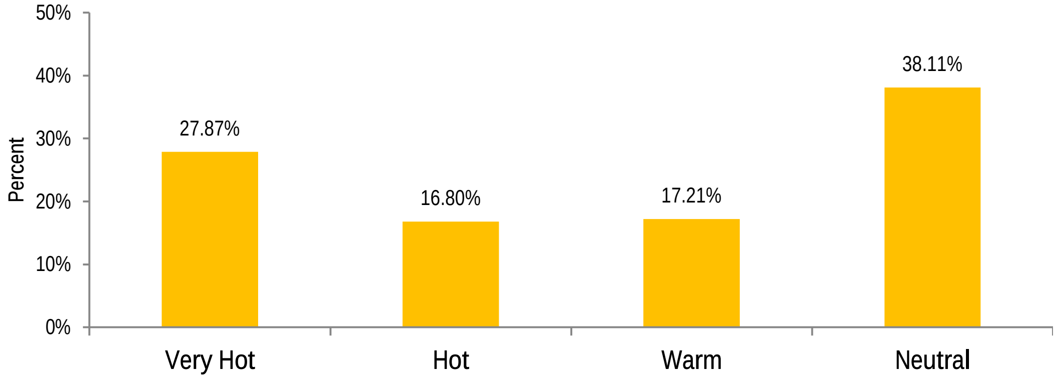


Figure 6.12 Participants' votes regarding their thermal sensation (Q. 13)

(2) Thermal preference (Q. 14)

It is particularly important to highlight here that the observations obtained from piloting the questionnaire revealed that the participants in the sample found some difficulty in using the adopted scale to express their preference to adjust the temperature at the time of interview. Therefore, before the participants commenced filling in the questionnaire, the way to answer this question on the scale was explained and exemplified, so as to simplify the voting and to avoid ambiguity and misunderstanding. Figure 6.13 below illustrates that 38% of the participants preferred "No Change" to their current thermal sensation, while nearly an equal proportion preferred "Slight Decrease" and "More Decrease"; 17.2% and 16.8%, respectively. However, the remaining 28% preferred "Much Decrease" to their ambient thermal conditions.

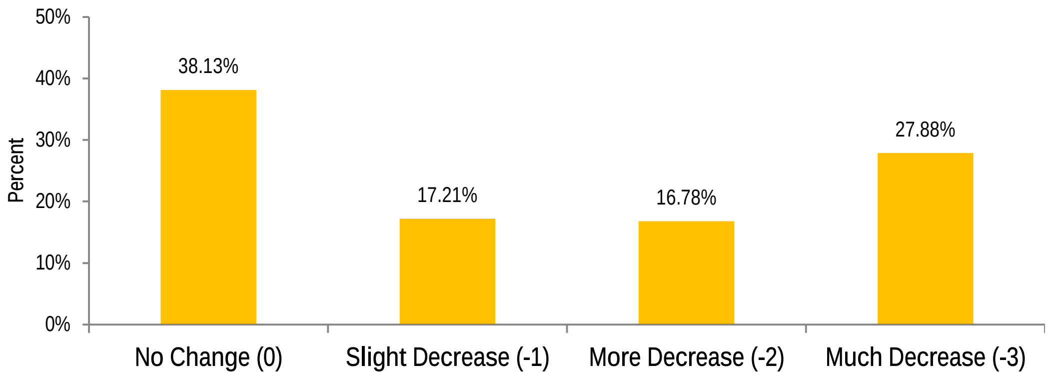


Figure 6.13 Participants' votes regarding their thermal preference (Q. 14)

What is also important to explain here, however, is that the relationship of the thermal preferences in the graph above does not directly correspond to the thermal sensation votes shown in Figure 6.12. That is to say, each vote on the preference scale may be based on a different thermal sensation. For example, when a participant indicated that his thermal sensation was “Warm” and that he preferred a “Slight Decrease” (-1), this means he wished to go one step back from his current thermal state, to the state represented as “Neutral” on the thermal sensation scale. Another example is when a participant identified his thermal sensation as “Hot”, and then preferred a “Slight Decrease” (-1); this actually means he preferred to become “Warm” on the thermal sensation scale. In the same context, if a participant preferred “No Change”[63], this reflects his preference to stay in the current state of his thermal sensation, regardless of the selected thermal sensation (i.e. “Neutral”, “Warm”, “Hot” or “Very Hot”).

(3) Preferences for wind speed, humidity and level of shading (Q. 15, 16 & 17)

The proportions of participants who preferred “More Air Movement” and “Less Humidity” were almost equal, at 63.9% and 66.4%, respectively. Regarding preferences for the level of shading, the results showed not much difference between the number of participants who preferred “No Change” and those who preferred “More Shade” (Figure 6.14). This last point was expected, because the majority were interviewed in the late afternoon and at night, excluding the small group (n=37) who were interviewed at midday under shade, in the case of King Khalid Street (see Chapter Five, section 5.6.4).

[63] This can be interpreted as reflecting the enjoyment by the participant of the physical activity being practised, for example, even if it means becoming quite hot.

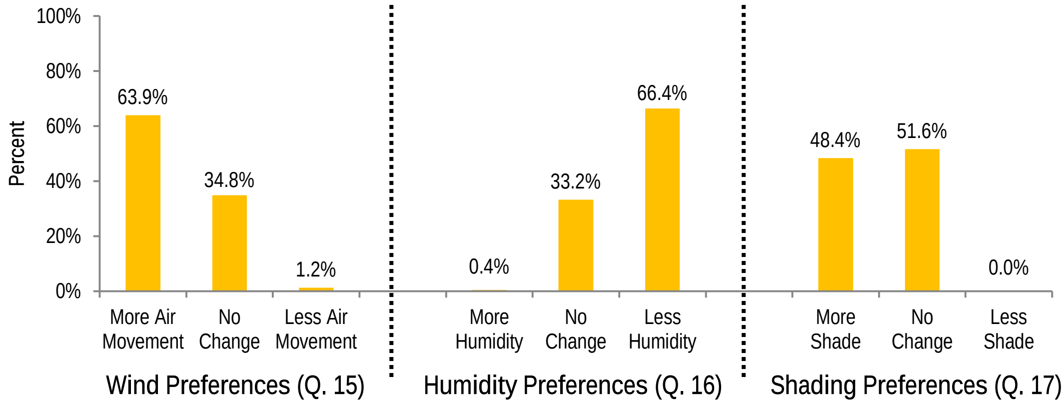


Figure 6.14 Distributions of the participants' preferences regarding wind speed, humidity and shading

The figure above shows a very strong indication of the pedestrians' preferences for both more air movement and less humidity. This was not an unexpected finding, because humidity in Dammam is recognised as relatively high, which often causes discomfort, particularly at night when accompanied by high temperatures.

(4) The relationship between walking places and temperate conditions (Q. 18 & 23)

The last question in Part II represents a transitional item from measuring the participants' thermal comfort to measuring their socio-cultural aspects and behavioural patterns associated with walking. This was a candid question aimed to demonstrate the level of impact of weather (independent variable) on walking (dependent variable), and hence to explore any causal relationship between the two, subjectively.

The participants were asked to rate how frequently they had actually walked in selected indoor and outdoor environments in the months before the interview, when climatic conditions were temperate (Jan-March). The results showed that 77% of the sample, who reported that they walked 'very frequently' during this period, indicated that was in outdoor spaces compared to only 23% walked 'very frequently' indoors (Figure 6.15). However, the proportion of the participants who walked outdoors could be larger, given that more than 68% reported they walked outdoors, but not frequently. The chart below implies that whenever the participants voted 'very frequently' for walking in outdoor spaces during the moderate weather, their tendency to walk indoors became less favoured.

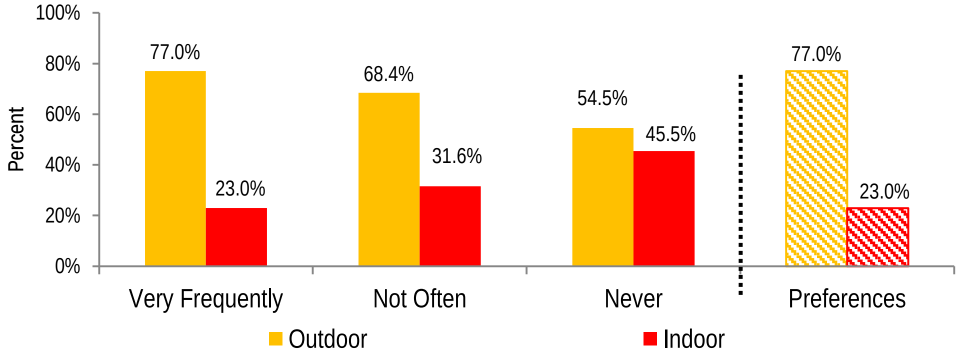


Figure 6.15 Frequency of walking rates compared to walking places during temperate climate, and the participants' preferences for walking environments (Q. 18 & 23)

Further, although the question asking the participants about their preferred place for walking was originally included in Part III, it is considered important to present the findings here for consistency. The chart above shows that 77% of the sample expressed their general preference for walking in outdoor places compared to a low proportion (23%) who preferred indoor settings, regardless of the state of weather.

6.2.1.4 Findings of PART III: measuring the socio-cultural and behavioural aspects of the pedestrians

In this part of the questionnaire, certain socio-cultural attributes of the participants, including their behavioural patterns and lifestyle aspects, were measured. The components of Triandis' theory (see Chapter Two, section 2.4.1) were also examined, since the ultimate goal of this research is a behavioural change.

(1) Walking patterns: frequency, duration and time preference (Q. 19, 20 & 24)

To understand the current lifestyle of the actual pedestrians, it was essential to produce some comparison studies of independent variables, which could reveal some significant tendencies that require more attention. For this, gender is compared with walking frequency, average duration of walk and time preference (Figure 6.16).

- *Walking frequency*: 72.6% of the female participants were walking less than 5-times per week compared to 62.6% of the males, who were walking ≥ 5-times a week. However, it was found that 52% of the overall walking frequency tended to be ≥ 5-times per week. These ratios reaffirm that women may have fewer opportunities than men for walking outdoors.

- *Average walking duration*: nearly 81% of the females tended to walk for ≥ 30 minutes compared to 56.7% of the male participants. Overall, 64% of the total sample reported that they typically walked for 30 minutes or longer.
- *Time preference*: there was an almost unanimous agreement among the participants (94.1% of the male participants and 94.4% females, and 94.3% of the total sample) that they usually preferred walking from late afternoon onward; i.e. after 4pm.

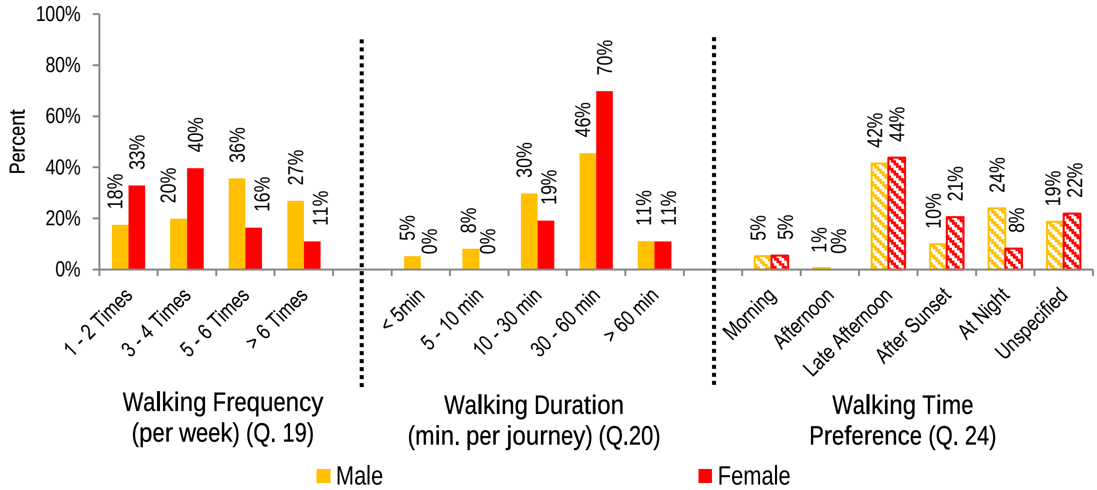


Figure 6.16 Frequency of walking frequency, duration and time preference, by gender

(2) Walking purposes (Q. 21)

In this particular question, the participants were free to choose more than one option that reflected their underlying purpose for walking. Figure 6.17 below shows that walking for general health and recreation constituted the major motives, for 72.4% and 69% of the participants, respectively. However, the proportion of females who reported walking for these purposes was significantly higher than that for males, whilst walking as a transport mode was higher in the male group. This information may be interpreted as indicating that walking is currently perceived, by the participants, as an optional activity, or other considerations are contributing to discourage walking as a lifestyle. The other purposes were relatively secondary, although these fluctuated according to the gender.

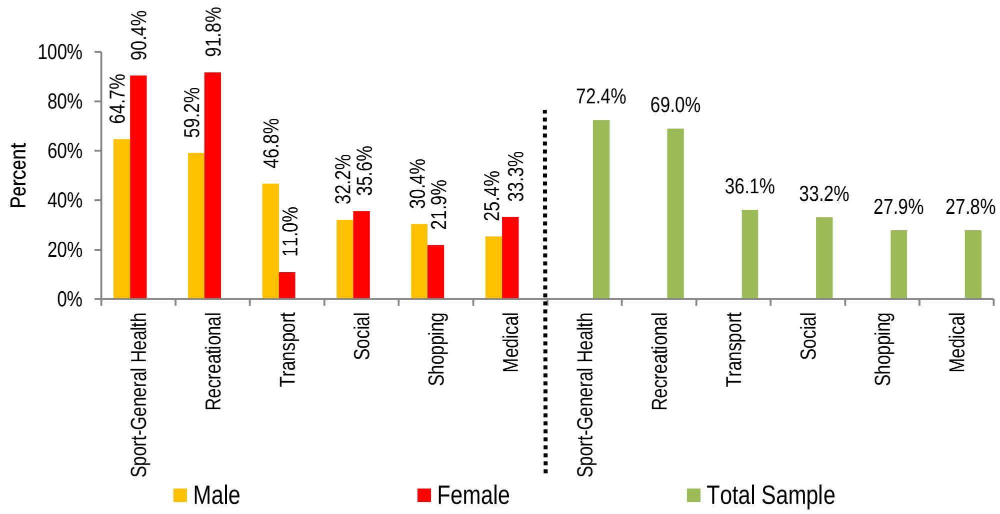


Figure 6.17 Frequency of walking purposes, by gender (Q. 21)

(3) Walking companions (Q. 22)

Another socio-cultural indicator that contributes in measuring walking behaviour is identifying with whom the participants usually go for walks, and hence, it was essential for the gender to be compared with use of walking partners. Figure 6.18 shows that 47.3% of the total participants (56.2% of males and 26.4% of females) often go walking alone. However, 52.7% of the participants reported they were more often accompanied by someone. Such information may confirm Rapoport's argument (1991), which emphasises that walking is primarily culturally based. However, other factors may also play an influential role such as the need to feel safe, particularly for women, among whom 73.6% reported that their activity was mostly undertaken in the company of others.

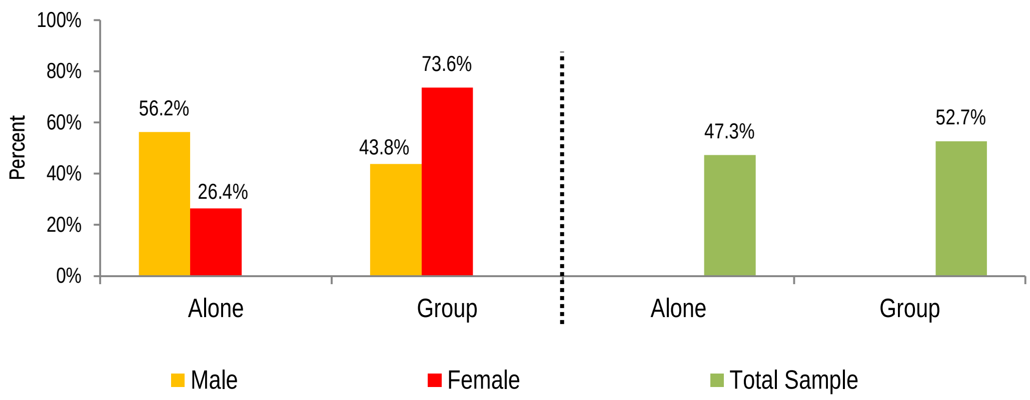


Figure 6.18 Distribution of participants' votes regarding their walking company (Q. 22)

(4) Impact of personal proximity on walking (Q. 25)

Owing to the fact that less is known about the impact of certain socio-cultural aspects, particularly in the Middle East, on the design of contemporary streets for walking, it was essential to measure the personal space between pedestrians, subjectively. Thus, there was a straightforward question exploring the participants' support or acceptance that the personal proximity to other pedestrians has an impact, exclusively, on their use of pavements for walking. Figure 6.19 reveals that nearly 71% of the sample agreed that other walkers' proximity had an influence on their use of pavements, compared to 16.4% who disagreed and 12.7% who voted that they felt neutral on this.

What is really interesting to emphasise here is the significant impact of this issue on women. 94.5% of the female participants agreed that such an 'innate' human dimension represents a contributing factor inhibiting their intention and tendency to use the pavements for walking. This can be interpreted as suggesting that personal proximity to other pedestrians is most likely to cause an experience of discomfort on the streets, and thus may greatly contribute in pushing them somewhere else more spacious and more convenient.

Such a finding has never been explored among pedestrians or within the urban environment, at least in the KSA and most likely not within the entire Arab region. However, it is an acceptable 'hidden' socio-cultural aspect, which has its roots especially in a Muslim society, where the Islamic principles[64] are considered binding on any member to observe and maintain. Based on this finding, it is crucial to consider this factor seriously; thus, it needs to be taken into further investigation.

[64] The Islamic principles impose on all community layers the obligation to maintain appropriate physical distances between the opposite sexes without family ties, as a form of personal privacy. See Chapters Three and Four (sections 3.4.5, 4.3.2 & 4.3.3) for more details.

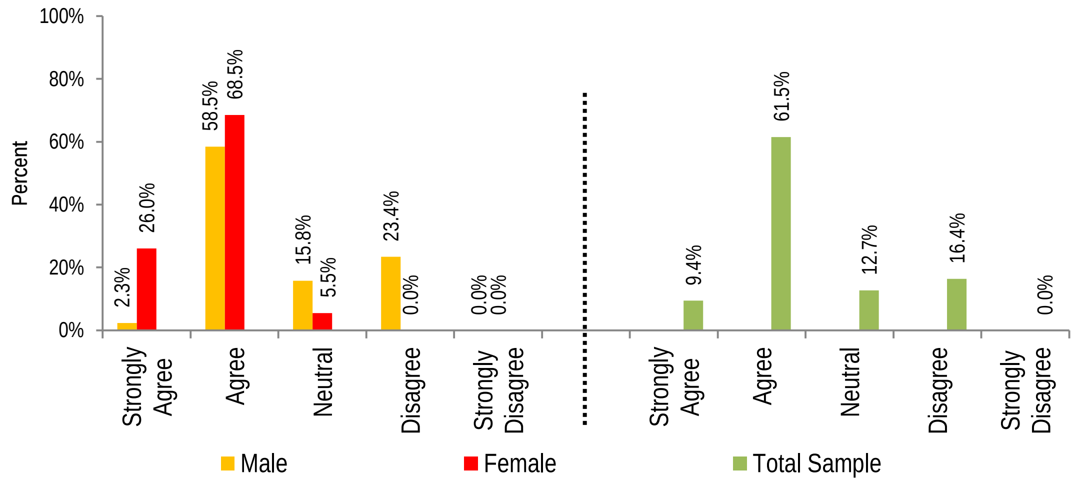


Figure 6.19 Frequency of the participants' votes regarding the impact of personal proximity to other people on their withdrawal from using urban streets (Q. 25)

(5) Preferences of personal distance for walking (Q. 26)

After the participants had evaluated the extent to which personal proximity affects their use of pavements, the natural question that needs to be answered next is their preferred distance for walking from other pedestrians. Thus, they were asked to select only one option from a list of distances which best reflects their comfortable personal space. Figure 6.20 shows that 41.4% of the sample (1/3 males and 2/3 females) preferred a personal space between 1.5 and 2m from other pedestrians when walking. This was followed by 20.1% who preferred 1.2-1.5m and 16.4% who voted ≤ 1.2m, whereas only 12.7% of the participants showed no preference. The proportions of participants with preferred distances of 2-2.5m and > 2.5 m were relatively close: 4.1% and 5.3%, respectively.

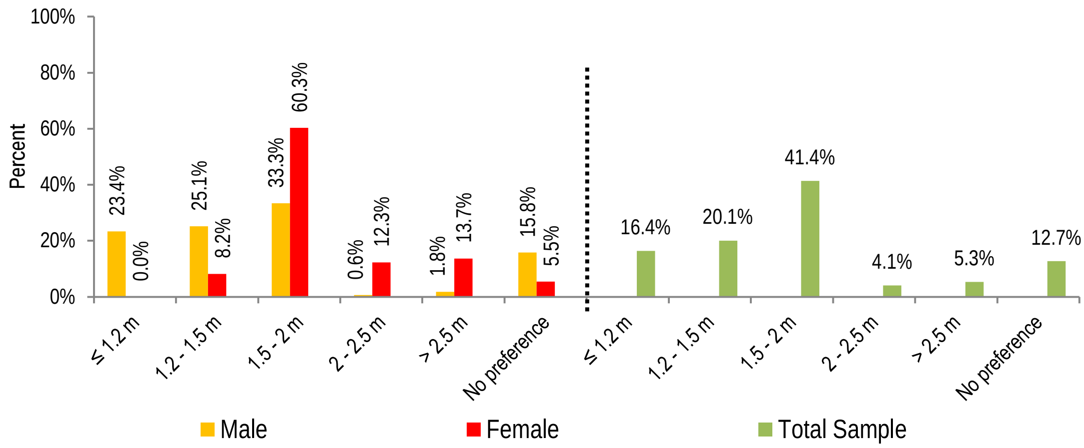


Figure 6.20 Distribution of the preferred interpersonal distance for walking (Q. 26)

What is really important to highlight is the female preference for the farthest distances, regardless of the gender of the other pedestrian. Evidently, females have much stronger considerations toward this issue, and hence this finding contradicts those of previous studies which found that the personal space among women is smaller compared to that of men or in situations of male-female interaction (e.g. Hall, 1966; Sommer, 1969; Gifford, 2007; Gifford et al., 2011). It was also found in this study that pedestrians who do not know each other tend to instinctively maintain a relatively large distance when walking, standing or sitting, in the culture of Saudi society. Such a preference becomes more demanding in urban spaces, and hence poses a real challenge to encourage their use, especially for urban streets to sustain the pedestrians, where male-female interactions are unavoidable and represent a sensitive socio-cultural aspect.

Furthermore, three points can be deduced from such information: (a) this finding identifies distinctive cultural perceptions of personal space in the Saudi urban setting; (b) it suggests the need for the design of the physical and spatial characteristics of urban streets to carefully consider and fulfil this quality; and (c) an in-depth exploration of this dynamic phenomenon and its implications on the built environment is highly recommended for further studies.

(6) Measuring habit vs. intention in the prediction of future walking under temperate conditions (Q. 28)

Based on Triandis' 'TIB' theory, habit and intention constitute separate paths to the behavioural outcome. Thus, habit can bypass people's intention to determine activity directly, unless some facilitating conditions are introduced. Accordingly, this question measures the impact of temperate weather (as facilitating conditions) on the participants' actual intention to walk, under the influence of their current lifestyle (habit), in which they have become accustomed to drive to certain destinations for walking. Figure 6.21 shows that the proportion of participants who expressed their strong tendency (i.e. Very Likely) to actually walk outdoors if the weather was temperate dominated the sample, with four out of five (80.7%) voting for this choice. Only 11.9% voted 'Somewhat Likely', while 7% preferred their decision to be made at that moment (i.e. Neutral).

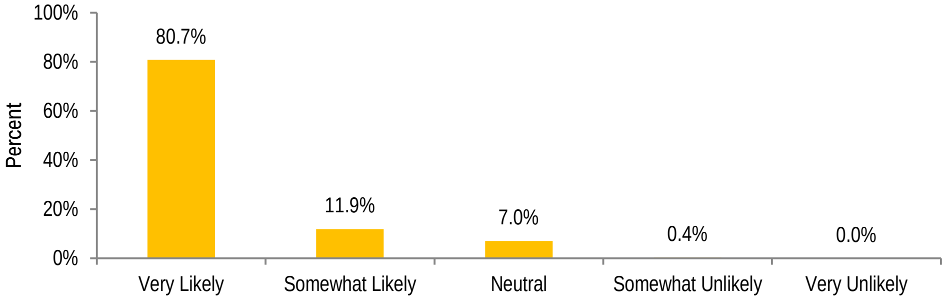


Figure 6.21 The participants' tendency for actual walking, if they have the intention and the weather is temperate (Q. 28)

What can be inferred from the chart above is that habit does not always override intention, but habit needs to be moderated by appropriate facilitating conditions, which was the temperate climate in this question. Such a finding does not only verify Triandis' theory, but also delineates the extent to which climatic conditions are a major factor that can support or undermine the intention for walking.

(7) Pedestrians' preferences for outdoor walking places (Q. 30)

After the participants showed their degree of probability to walk, provided that the microclimate is temperate, the following question was intended to ascertain their preferred outdoor environment for walking. Figure 6.22 shows that 51.6% of the interviewees prioritised constructing more walking tracks, whilst 48.4% preferred the development of existing streets to accommodate walking more conveniently. The 3.2% difference between the two may seem, at first glance, be inclined to the walking tracks, indicating that the pedestrians often find these spaces respond better to their needs; however, on a closer examination, it is less conclusive.

By considering this question by gender, it becomes evident that there is a clear contrast: 76.7% of the female participants preferred the walking tracks compared to the 59.1% of males who prioritised developing urban streets. Thus, it could be explicitly stated, from this variation, that females have much stronger concerns than males toward using streets for walking, or that existing streets per se have become inconvenient to satisfy the female pedestrians.

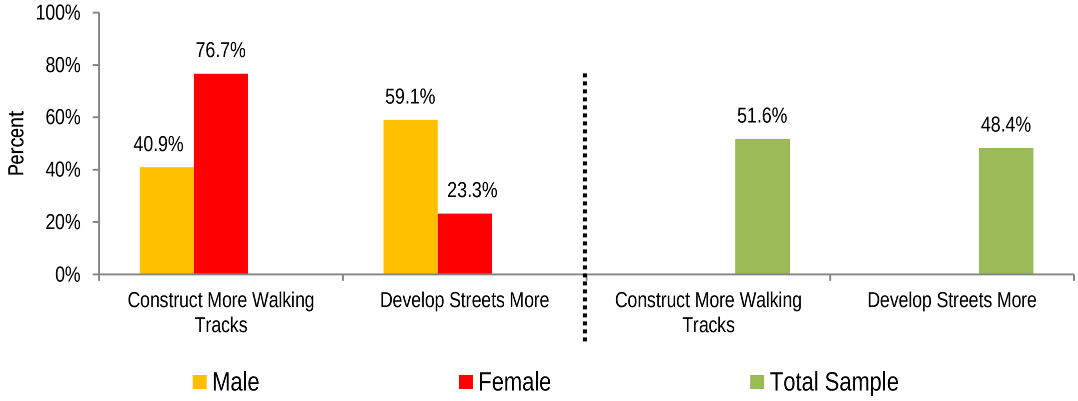


Figure 6.22 Distribution by gender of participants' preferences for outdoor walking environments (Q. 30)

Only six participants (n=6) added comments justifying their answers, whereas the majority left the 'reason' field blank (see Chapter Five, section 5.6.7); these justifications are grouped into two categories: (a) the participants who preferred the walking tracks attributed their answers to the existing conditions of urban streets, which have become a pedestrian-hostile environment, accounted for by the constant priority for cars and limited attention to pedestrians, and (b) the participants who supported the development of urban streets highlighted that the contemporary streets have lost their sense of place[65], and have become a boring environment for walking, due to the lack of greenery.

(8) Measuring the impact of certain socio-cultural factors on walking (Q. 31, 33 & 34)

Triandis' theory (1977) emphasises that the social context surrounding an individual can play a significant role in governing that person's behaviour. Similarly, Rapoport (1991) asserts that cultural variables are primary for any activity and behaviour, including walking on streets. These assertions were coupled with the observation which established that one of the latent reasons, for some layers of the Saudi society, to use other urban places for walking, instead of streets, was due to the sensitivity to being seen walking (see Chapter Four, section 4.3.1). Accordingly, it was essential to identify the degree to which certain socio-cultural factors are exerting a dominant influence on the pedestrians' withdrawal from the street space.

[65] They termed it: "lost its soul and essence".

Figure 6.23 below shows the findings of measuring pedestrians' votes[66] for: **(a) Q31:** the effect of family and friends on walking; **(b) Q34:** social acceptance of walking as a civilised behaviour; and **(c) Q33:** socio-cultural barriers (e.g. to avoid flirtations or being seen walking). ***Firstly***, 36.9% of the participants (33.9% males and 44% females) strongly agreed that people close to them played a role in increasing their awareness towards walking. ***Secondly***, 48.4% of the sample (44.4% males and 58% females) voted 'strongly agree' that the people most important to them believed walking is an essential activity. ***Thirdly***, 42.6% of the interviewees (49.7% males and 26% females) strongly disagreed that their main reason for walking outside the street space was often due to a desire to avoid some of the negative social behaviours.

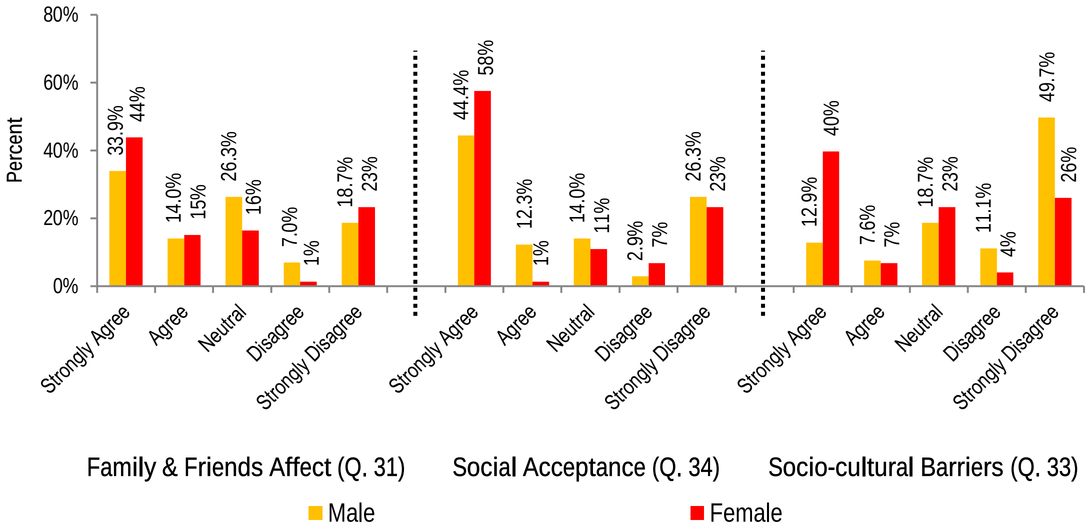


Figure 6.23 The participants' votes regarding the influential role of three socio-cultural factors on their tendency for walking, by gender

Although the first two questions may be comprehended as a reflection of the increasing public awareness towards the benefits of outdoor walking, the third factor entails a further interpretation. A closer examination of participants' responses discloses that 40% of the females were more sensitive about the impact of some of the negative social behaviours. Their responses may be attributed purely to social concerns, but may also be connected to unresponsive street design to certain socio-cultural requirements. For example, women may have a desire to move away from physical contact with men as a result of the narrow pavements. Such a finding may

[66] These three items were originally presented in the questionnaire, separately.

become consistent with, and further interpret the women’ preferences for more walking tracks being constructed (see point (7) above).

(9) Measuring the impact of certain socioeconomic factors and preference for lifestyle change (Q. 29, 35 & 36)

The last section of PART III focused on two socioeconomic factors: public transport (**Q29**) and fuel prices (**Q35**). This was coupled with an exploration into the pedestrians’ preference for changing their current lifestyle to return into the street space, provided that the space had been reclaimed for walking (**Q36**). The first two items are most often interconnected with the increase in sedentary lifestyles and the decline in walking. Gehl (2010) states that a good urban space, for walking, and a good public transport system are simply two sides of the same coin. Newman and Kenworthy (2015) further argue that once one of these two factors is in place, walking and cycling tend to follow. Thus, one question was aimed at understanding the participants’ intention to use streets for walking if quality public transport was introduced. The other one focused on assessing the impact of the current low fuel prices on pedestrians’ attitude toward walking in other urban places, instead of streets.

Figure 6.24 shows that 71.3% of the sample expressed the high likelihood that reshaping the street space to accommodate highly efficient modern public transport would be a stimulating factor in fostering their decision to walk on the streets. With regard to identifying to what degree the existence of cheap fuel contributes in making the pedestrians unconcerned about improving street design for walking, 34.4% of the responses were ‘neutral’. However, there was a clear difference between those who voted ‘somewhat likely’ (7%) and ‘somewhat unlikely’ (6.1%), and similarly among who voted ‘very likely’ (23.4%) compared to ‘very unlikely’ (29.1%). Moreover, almost 65% (66.1% males and 61.6% females) showed a strong desire to return to the street space.

These answers clearly support the thesis of this research which reflects the view that the declining rate of using streets for walking in the KSA is not necessarily exclusively a consequence of the growing culture of car dependency. Moreover, they denote the dissatisfaction of these pedestrians, whether consciously or not, with the current lifestyle, which is based on the car use, and thus, the findings for this item differ from the results measuring their preferred outdoor place for walking (see point (7) above).

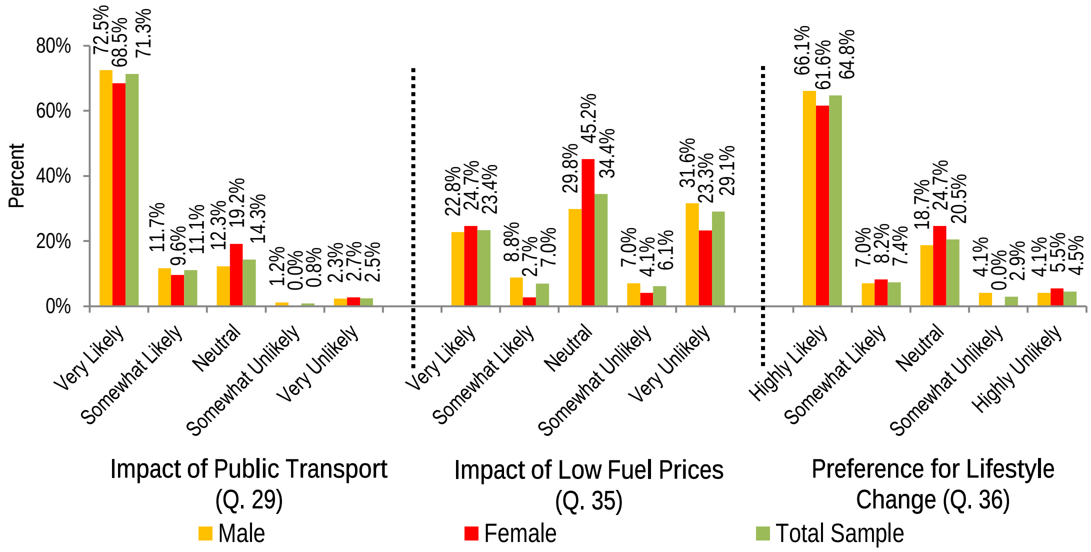


Figure 6.24 Frequency of the participants' votes, by gender, regarding the impact of specific socioeconomic factors on their walks, and their desire to walk on streets in the future

6.2.1.5 Findings of PART IV: measuring the physical and spatial attributes of urban streets

After the participants expressed their preference for changing their current lifestyle, it is appropriate for the next exploration to identify what characteristics of street design they prefer to keep, improve, introduce or completely remove from the street space. Consequently, PART IV completed the interviews by asking the participants to rate their level of agreement with statements regarding specific design characteristics. These characteristics were derived from the pilot study and literature review (see Chapter Three, Table 3-3). This part highlights how responsive these characteristics were to the desires expressed in the previous two parts, hence revealing the cause-and-effect relationship between street design and walking. That is aimed, eventually, to suggest the required level of design interventions (physically and spatially), which can contribute to reclaiming the street space under hot-humid climatic conditions, and thus to restore walking.

(1) Measuring the impact of selected attributes related to the pedestrian zone (Q. 37, 38, 39 & 40)

Figure 6.25 below shows that 83.6% of the participants strongly agreed that the existing conditions of the pavements are poor, and hence they considered the space discouraging for walking. The same figure also shows that 81.6% were strongly convinced that the width of the pavements is insufficient to accommodate their walking needs. Moreover, 83.6% strongly agreed that planting practices, by neighbours, have contributed in narrowing the available footway width. In connection with this, 79.1% of the interviewees felt very disturbed by neighbours' encroachments on the pavement space.

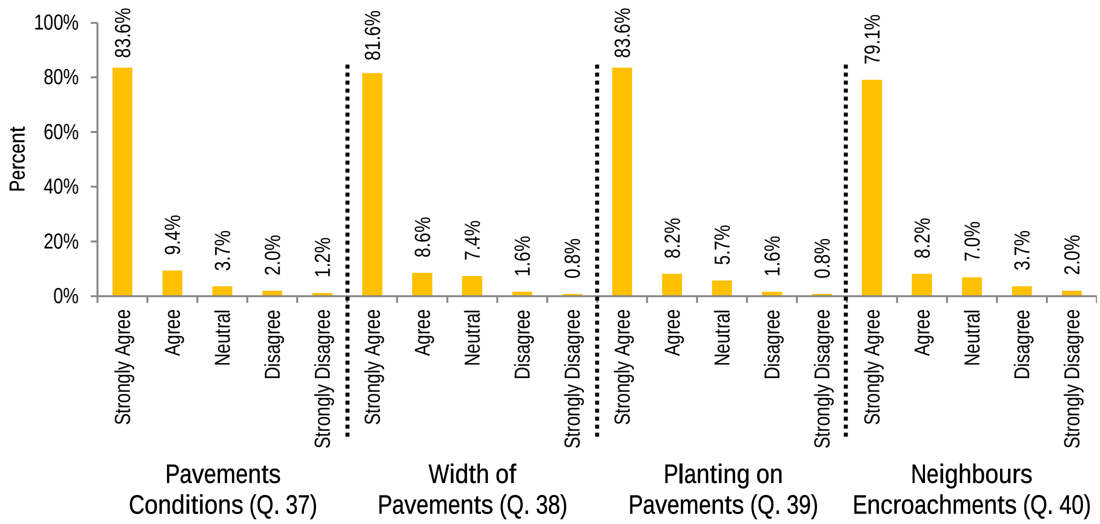


Figure 6.25 Pedestrians' assessment of the impact of some pavement-related attributes

(2) Measuring the impact of safety methods (Q. 41, 45, 46 & 52)

Figure 6.26 reveals that almost four-fifths of the sample regarded the available safety measures with dissatisfaction, including (a) 84.4% who strongly agreed that there is an obvious lack of effective methods segregating pedestrians' movement from vehicles; (b) 83.6% who wanted more regularly-distributed pedestrian crossing zones; (c) 77.5% who supported the incorporation of more speed bumps within neighbourhoods and (d) 88.5% who expressed a strong preference for urban streets to be equipped with surveillance cameras.

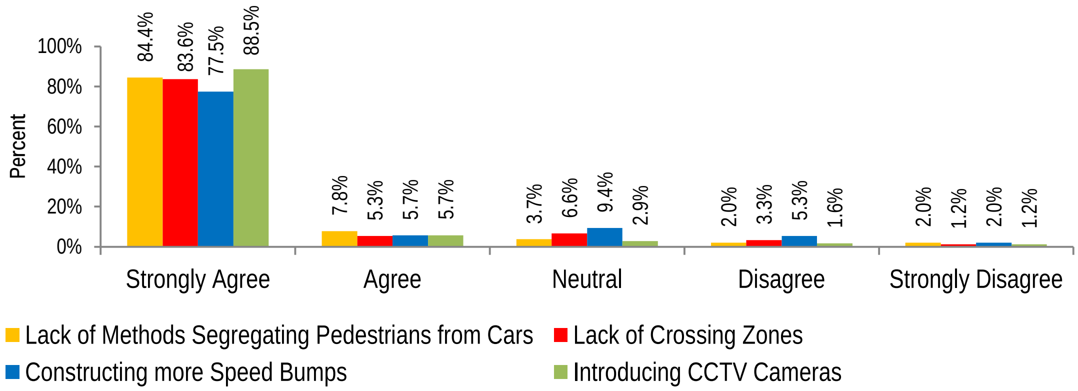


Figure 6.26 The participants' votes regarding selected safety measures (Q. 41, 45, 46 & 52)

(3) Measuring the impact of selected streetscape elements

Because the components of the streetscape are at eye level, on the microscale of the street space, where pedestrians experience walking and require noticeable differences, complexity and details, it was crucial to measure how the actual pedestrians evaluate the existing streetscape components. Quality of these components is what can contribute, practically, in making walking either a comfortable or stressful experience.

Figure 6.27 shows that 77.5% of the participants strongly agreed that quality and colours of the existing paving materials, which are replicated in most streets contribute to a boring walking experience. Almost 80% strongly agreed that pavements equipped with benches will encourage them to make use of the streets on foot. An interesting finding revealed that nearly 84% strongly agreed that the concept of marking the distances on pavements (length of the pavement) should be incorporated. Their responses to the statements regarding these streetscape elements can be interpreted as expressing an overall dissatisfaction with their existing conditions.

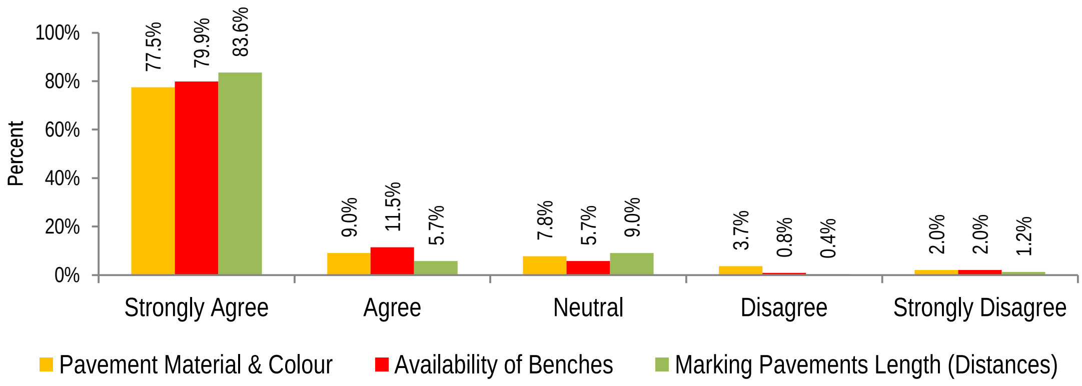


Figure 6.27 Distribution of the participants' votes regarding some streetscape elements (Q. 42, 49 & 53)

Three additional streetscape components were also measured. Figure 6.28 shows that 79.1% of the participants strongly agreed that streetscape elements are badly and randomly placed on pavements, hindering smooth walking. In terms of the visual quality, 79% strongly agreed that the existing street design is unappealing whether for walking or staying, owing to the excessive use of concrete and poorly designed signs. In connection with the latter point, nearly 77% strongly supported the statement that the street lighting is poorly designed for pedestrians, which contributes in degrading the visual quality of streets at eye level.

Overall, all results under this section can be interpreted as indicating that the existing physical and visual conditions of urban streets are all signals to pedestrians visiting the street space about lack of care and concern for street quality. Thus, the responses confirm Gehl's observation that "Concern for city life is often totally absent from considerations about the placement […] and the choice of design and materials" (Gehl, 2010: 144).

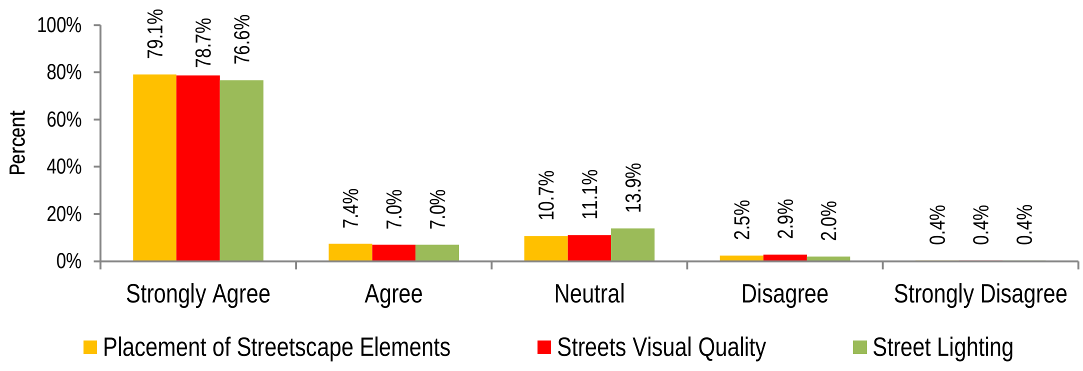


Figure 6.28 Distribution of the participants' votes regarding the quality of selected streetscape elements (Q. 47, 48 & 50)

(4) Measuring the impact of proximity to neighbourhood parks and services (Q. 44 & 54)

82.4% of the participants expressed a strong support for the role of parks and playgrounds within neighbourhoods, as an incentive to walk on streets. However, their assessment of the importance of proximity to daily services varied (Figure 6.29). About 43% of the sample disagreed with the statement that the distance between their place of residence and the basic daily services was farther than they could walk, while 35.7% were neutral and only 21.4% agreed.

Unlike some studies conducted in Europe and North America, the results presented here did not reveal a relationship between proximity to services and using streets for walking. The chart below demonstrates that such a factor is insignificant to encourage walking, in the Saudi context, and hence draws attention to the importance of other factors, mainly street components at the microscale, which appear to play a more influential role.

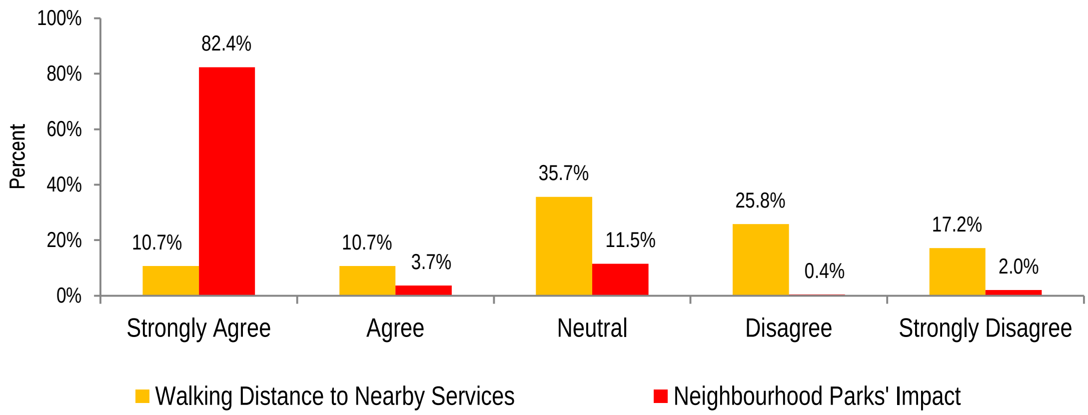


Figure 6.29 The participants' votes regarding the impact of proximity to facilities and services, within neighbourhoods, on their decision for walking (Q. 44 & 54)

(5) Measuring the impact of streets' thermal conditions (Q. 43 & 55)

This section concluded the questionnaire by asking the participants to rate: (a) the impact of the lack of street shading on their reluctance to use streets for walking on a daily basis[67]; and (b) their preference for the idea of incorporating methods to increase air movement. Figure 6.30 demonstrates that 84% of the participants strongly agreed that the lack of shaded streets was one of the key factors leading to their withdrawal from the street space. Nearly 86% of the sample showed a strong preference for the concept of incorporating ventilation methods into the street space, as incentives for walking.

These findings, although they may not be surprising, nevertheless reinforce an unequivocal conclusion. If street design can provide shading, whether by its configuration or by the use of physical shading elements with high albedo materials to reduce the impact of intense solar radiation at pedestrian level, coupled with introducing methods to accelerate wind speed during high diurnal and nocturnal temperatures that are often accompanied with high rates of humidity, walking is very likely to increase. Correspondingly, the pedestrians, consciously or not, may find it more appropriate to return into the street space.

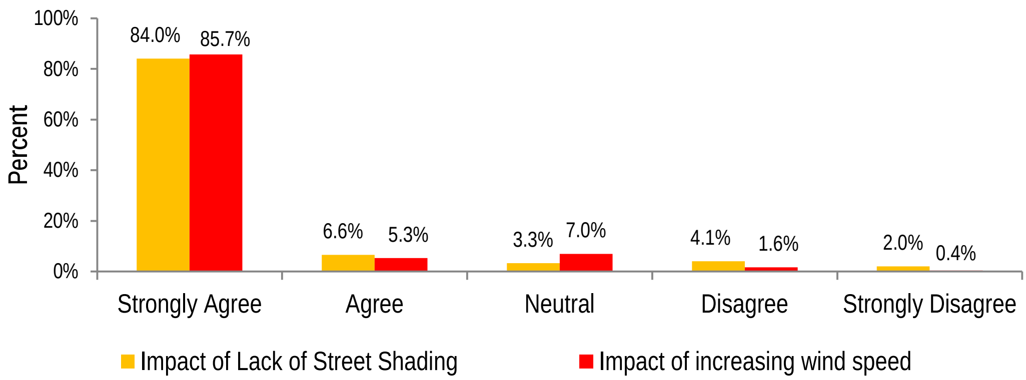


Figure 6.30 Distribution of the participants' assessment of the impact of shading and air movement on their intention to use streets for walking (Q. 43 & 55)

[67] Although this item may seem a leading question, it was posed with the aim to understand the participant's subjective evaluation of the relationship between street design and urban microclimate, for later comparisons.

6.2.2 Statistical Analysis

6.2.2.1 Identifying the pedestrians' thermal comfort *(PART II)*

This section aims to identify the acceptable outdoor thermal conditions in Dammam, by defining the upper thermal comfort limit of the pedestrians above which walking would be an intolerable experience. This included identifying the most influential environmental factors associated with the pedestrians' thermal sensations. In the most part, linear regression models are used to assess the correlation between the variables.

6.2.2.1.1 Relationship between the participants' thermal sensation vote and the PET values

After the PET values had been generated through use of RayMan, based on the calculation of the measured meteorological factors at the time of the interviews, combined with the thermo-physiological factors, height, weight, age and gender of every participant, these values were plotted against the thermal sensation vote (TSV). The generated linear regression (Figure 6.31) shows a strong positive correlation (R^2 = 0.7128) between the two factors. Such a relationship can be expressed by the following equation:

TSV = (- 0.1148 x PET) + 6.823 **Equation 4**

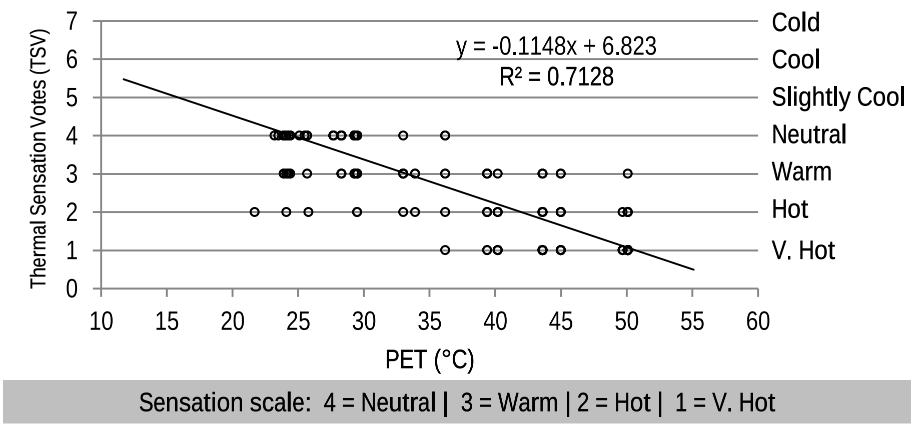


Figure 6.31 Thermal sensation votes of all participants vs. their corresponding PET values

According to Equation 4 and the graph above, the upper thermal comfort limit of the pedestrians was found to be 33.3°C PET. This means, according to the trend-line in the generated linear regression, that above such a PET value, the pedestrians would feel warm. However, outdoor pedestrians are subjected to a variety of influential factors[68] leading to variations in their responses toward the surrounding thermal conditions. Therefore, in order to remove the effects of this variation, the set of the calculated PETs was divided into a total of 10 data bins with an increment of 2°C.

Adopting such an approach has been proven, in a relatively similar study (Alznafer, 2014), to be an effective technique in classifying the measured votes. Hence, a mean thermal sensation vote (MTSV) of the total sample that fell within each data bin was specified. The generated linear regression (Figure 6.32) shows a stronger relationship (R^2 = 0.9112, $P < 0.001$) between the MTSV and PET values, which can be illustrated through Equation 5. As a result, the upper thermal comfort limit for the outdoor pedestrians in Dammam was estimated as 31.5°C PET.

$$MTSV = (- 0.1095 \times PET) + 6.4627 \qquad \textbf{Equation 5}$$

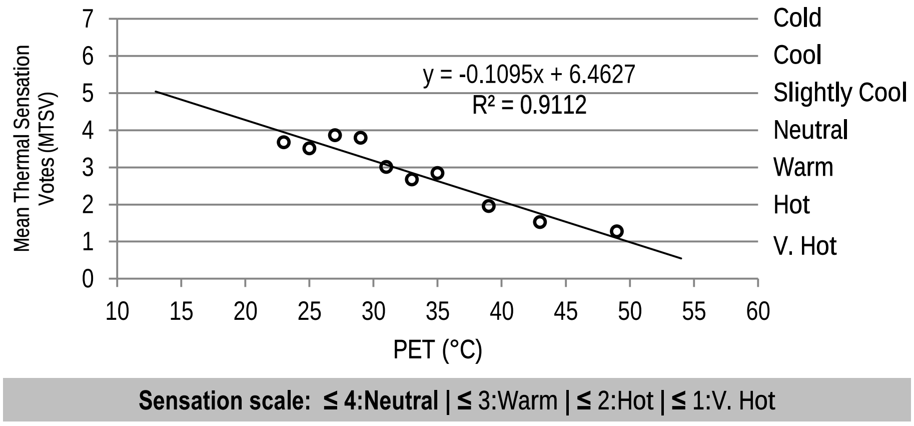


Figure 6.32 Mean thermal sensation votes vs. their corresponding PET values

Table 6-3 below summarises the MTSV, the minimum and maximum TSV, number of votes and standard error of mean that fell within each data bin of the PET values. The table shows various TSVs in each data bin, which might be attributed to several factors related to physiological and psychological adaptations including naturalness,

[68] For example, an individual's history of exposure to the environment under study (Nagara et al., 1996), expectations, thermal history with the urban space under investigation and/or psychological adaptations (Höppe, 2002; Nikolopoulou & Steemers, 2003; Alznafer, 2014).

expectations, experience, time of exposure and perceived control (Nikolopoulou & Steemers, 2003).

Table 6-3 PET values of the mean thermal sensation votes of the total sample

PET (°C)	MTSV	No. of Votes	Std. Deviation	TSV - Minimum	TSV - Maximum
23.1 - 25.0	3.67	27	.555	Neutral	Hot
25.1 - 27.0	3.50	6	.837	Neutral	Hot
27.1 - 29.0	3.86	21	.359	Neutral	Warm
29.1 - 31.0	3.78	60	.490	Neutral	Hot
31.1 - 33.0	3.00	9	.535	Neutral	Hot
33.1 - 35.0	2.67	3	.577	Warm	Hot
35.1 - 37.0	2.83	6	1.169	Neutral	V. Hot
39.1 - 41.0	1.95	21	.805	Warm	V. Hot
43.1 - 45.0	1.52	50	.677	Warm	V. Hot
49.1+	1.27	41	.501	Warm	V. Hot
Total	2.66	244	1.248	Neutral	V. Hot

6.2.2.1.2 The estimated PET and its equivalent Ta, Tg and RH

After discovering the correlation between the MTSV and PET, and hence defining the upper thermal comfort limit, it is important to find out next the relationships between the calculated PET values and the four environmental variables measured at the interviews. The purpose is to identify the equivalent value of each variable associated with the upper comfort limit. Thus, a regression model was generated to assess the relationship between the PET, as a dependent variable, and Ta, Tg, v and RH, as independent variables. Figure 6.33 shows the generated linear regression between the estimated PET and the measured Ta.

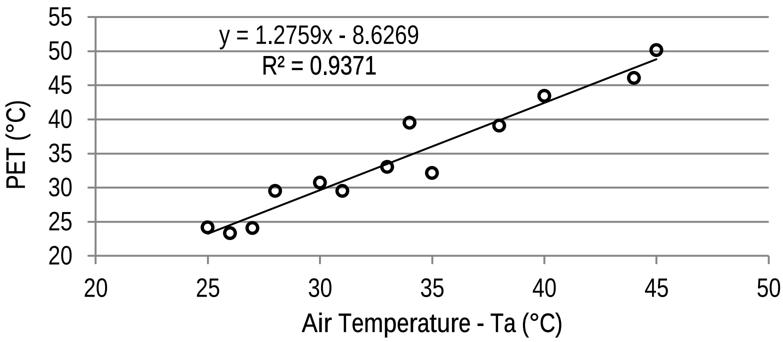


Figure 6.33 Correlation between the calculated PET and measured air temperature (Ta)

The above figure shows a significant correlation between the PET and Ta (R^2 = 0.9371), and their relationship can be expressed in the following equation:

PET = (Ta x 1.2759) - 8.6269 **Equation 6**

Similarly, Figure 6.34 below shows a significant correlation between the PET and Tg (R^2 = 0.9913), and their relationship can be expressed in the following equation:

PET = (Tg x 1.3479) - 10.59 **Equation 7**

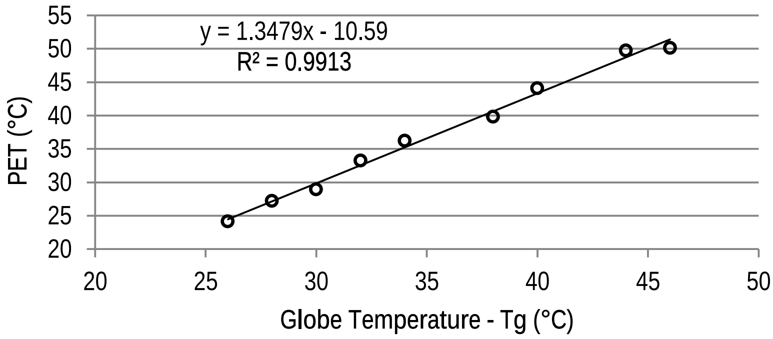


Figure 6.34 Correlation between the calculated PET and measured globe temperature (Tg)

Figure 6.35 shows that RH exhibited a strong correlation with the PET (R^2 = 0.7214), although is lower than that found between the PET and Ta and Tg, and hence their relationship can be expressed in the following equation:

PET = (-0.3469 x RH) + 48.337 **Equation 8**

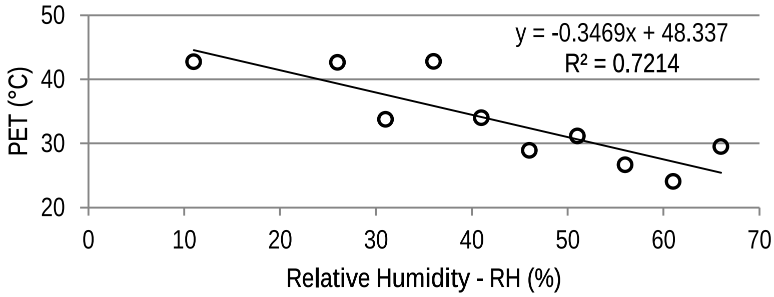


Figure 6.35 Correlation between the calculated PET and measured relative humidity (RH)

However, wind velocity showed weak correlation with the PET (R^2 = 0.0263). The reason for this weak relationship may be attributed to the constant change of wind velocity during the interviews, and hence clear fluctuation in the measured v values (Figure 6.36).

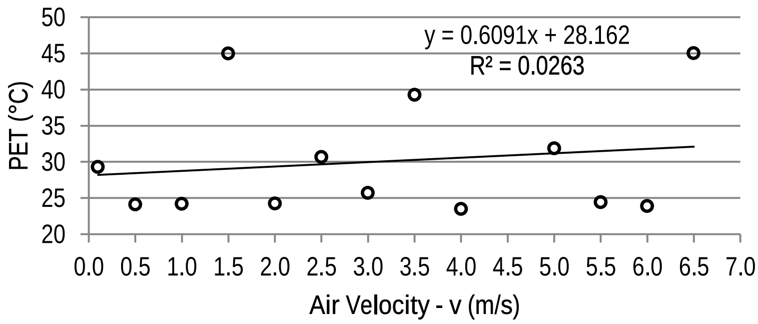


Figure 6.36 Correlation between the calculated PET and measured air velocity (v)

Drawing on the information presented above, Table 6-4 below lists a range of PET values and the equivalent Ta, Tg and RH values. These three environmental variables were found to be the most significant factors affecting the participants' TSV. The table shows that the PET value of the upper thermal comfort limit (31.5°C) was equal to 31.1°C Ta, 50% RH and 30.9°C Tg. Although the wind velocity did not show strong correlation with the PET, the upper thermal comfort limit was mostly associated with an acceptable range of wind velocity of between 2.7 and 3.2m/s.

Table 6-4 The PET value and its equivalent Ta, RH and Tg values

PET	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ta	26.4	27.1	27.9	28.7	29.5	30.3	31.1	31.8	32.6	33.4	34.2	35.0	35.8	36.5	37.3	38.1
RH	67.3	64.4	61.5	58.6	55.7	52.9	50.0	47.1	44.2	41.3	38.4	35.6	32.7	29.8	26.9	24.0
Tg	26.4	27.1	27.9	28.6	29.4	30.1	30.9	31.6	32.3	33.1	33.8	34.6	35.3	36.0	36.8	37.5

Upper thermal comfort limit →

A multiple regression between the TSV, as a dependent variable, and the participants' preferences toward levels of wind velocity, humidity and shading, as independent variables, was carried out. Table 6-5 shows that the three variables were found to have a significant impact on the thermal preference of the interviewees (*P* < 0.001).

Table 6-5 Regression analysis between the TSV and preferences toward levels of shading, relative humidity and wind velocity

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.060	.467		2.268	.024
Wind Preference	.666	.132	.261	5.048	.000
Humidity Preferences	-.550	.143	-.197	-3.854	.000
Shading Preferences	1.443	.125	.582	11.562	.000

a. Dependent Variable: Thermal Sensation

Finally, it can be concluded here that the findings of the interviews revealed the dual impact of key street characteristics on pedestrians' reluctance to walk on streets. Hence, urban designers and landscape architects who are interested in restoring the pedestrians into the street space are highly advised to pay careful attention to two levels of simultaneous interventions: physical and spatial, although these can be collectively grouped under three factors: ***comfort, quality and safety***,.

Firstly, the pavements should be widened with the notion of comfort in mind, in order to (a) adopt strategies of climatically-responsive design to provide thermal comfort, and (b) to accommodate the preferred personal distance. ***Secondly***, a serious consideration of the quality of streetscape elements should be taken into account, including: (a) quality of pavement conditions, (b) placement of street furniture including trees and (c) marking the distances on pavements, i.e. length of the pavement, for the convenience of the pedestrians to estimate the distance walked. ***Thirdly***, providing additional safety measures by means of physical elements (e.g. bollards) is necessary, whether to segregate pedestrian movement from cars or to prevent encroachments on the pavement space (e.g. parking cars on the footway).

6.3 Participant Observation

Observation is the second data collection method applied in this research. Its aim is to find evidence of the actual use and walking patterns of the pedestrians, and hence this section of the chapter responds to objective (4) of the present research. The observational records are investigated in the form of categories, in order to concentrate on certain aspects which are related to both the research questions and the aim of the research.

The analysis of the observation records for both selected sites (King Saud and 13th streets) has been classified into two parts: (a) the physical and spatial characteristics, including streetscape elements, and (b) the pedestrians, including their walking patterns, activities and interaction with the existing conditions of the street space. Both parts fulfil the two dimensions of unobtrusive observation, as described in Chapter Five (section 5.7.1); namely, observing the natural behaviour (walking) and the natural setting (street).

Thus, both parts intend to: (a) gain a better insight into the pedestrians actual walking patterns; (b) identify the level of impact of the existing conditions of the street space on walking; (c) identify the walkers' proximity to each other (personal space); and (d) specify (within the pavement space) where they sit or stand, what type of activities they engage in and what is the most frequent time of the day at which the pedestrian traffic becomes considerable. Once these issues have been explored, any similarities, variations, conflicts or nuances, between pedestrians' responses to the questionnaire and their actual use of the street space, will be identified.

Moreover, all the data recorded on maps have been digitalised through use of Adobe Illustrator for analysis. This was a crucial procedure which enabled the researcher to create several overlapped layers of walking patterns, pedestrians' activities and behaviours, based on the gender, day of observation and time. Such an approach was very useful to provide the researcher with both a detailed picture and an overall idea of how the entire environment was used

6.3.1 King Saud Street

This was the first constructed wide road in the history of Dammam. Its name was given after the second king, after the unification, and during his rule ARAMCO was commissioned to develop the city. This street was built as 30m wide and with E-W orientation, in order to separate the old irregular fabric from the proposed plan, which followed the gridiron pattern (see Chapter Four, section 4.2.4 for details).

6.3.1.1 Part One: the physical and spatial analysis

Figure 6.37 below shows the segment of the street selected for the observation. As a result of the urban regeneration process in the city, which was initiated in 2009, this street has received the largest share of attention, where radical changes have been undertaken at two levels, physical and spatial, as follows:

a) The vehicle zone was converted from a two-way arterial street into one-way route, and hence more space was gained to widen the existing zone to incorporate new traffic and parking lanes;

b) New building codes have been put into practice by forcing any development to the existing buildings or proposed ones to adopt traditional design vocabulary, and hence some of the existing projects applied the concept of false fronts;

c) An add-on arcade was constructed to the wall of an old public cemetery, and new shops were established;

d) The pavement space was widened and traditional concrete tiles were altered to interlocking pavers;

e) The standard lighting poles were replaced with decorative ones; and

f) Some streetscape elements such as benches, signs, planting, a fountain and bollards were incorporated.

Moreover, along this type of street, buildings are typically over 4-storeys, which results in commercial activities on the ground floor level and residential uses on the upper floors. It is also worth mentioning that the spaces between buildings, overlooking the street, are narrow and do not exceed 5m, at most. Most often, a second floor is built to connect two buildings, and hence serves as a covered walkway (Figure 6.38). This type of space will be referred to in the subsequent paragraphs.

Figure 6.37 The physical analysis of King Saud Street

Figure 6.38 Narrow and covered spaces between buildings always attract static pedestrians

6.3.1.2 Part Two: the pedestrian analysis

a) **Observation days and time:** the observation activities for King Saud Street were carried out for three days, from Wednesday 2nd May to Friday 4th May 2012, and took place between 4 and 7pm.

b) **Ethnicity and gender:** most of the observed pedestrians were Asian males and, although there were some Arabs, Saudis were the minority during the observation periods. Saudis were easily identified from non-Saudis through the national dress worn, and the style of wearing the Arabian Gulf costumes.

c) **Walking patterns and pedestrians' activities:** for simplification purposes, observation times will be used in this part, in order to concentrate on the required aspects for observation. Table 6-6 below shows the summary of observing the pedestrians for three hours on three successive days. The table also includes the average microclimatic conditions recorded during the observations and number of observed pedestrians, by gender.

- **Period #1 (4-5pm):** the pedestrian traffic was relatively low, and females were absent. Most of this movement occurred on the southern side of the street, whereas the walking pattern on the north side was only transient. The sedentary activities (standing and sitting) were typically taking place either at street corners or at intersections with narrow walkways between buildings. Both cases occurred on the southern side, where the pedestrians used the bollards. Thus, it can be clearly stated that the pedestrians were concentrated in any shaded place resulting from the adjacent tall buildings.
- **Period #2 (5-6pm):** there was a noticeable increase in pedestrian traffic, but no females yet. This period also witnessed the beginning of street vendors' activities who occupied any vacant place on the pavement: sometimes in the middle or on both edges of the pavement space (Figure 6.39). The pedestrians continued using the bollards for sitting, in the same spots observed as in the previous period. However, walking patterns witnessed some variations. Both sides of the streets witnessed more walking activity, although the southern side sustained more pedestrian traffic. This may be attributed to the type of activities, or the pavement space on the northern side may be less motivating. Moreover, transient walking was considerably lower than in the previous period, which can be interpreted as indicating that the street space had become a destination per se.

Figure 6.39 Street vendors typically occupy any vacant place on the pavement from after 5pm

- **Period #3 (6-7pm):** this was the actual beginning of the peak time for pedestrian traffic. What is really important to highlight here is that the sedentary activities (sitting and standing) had become intense: at street corners, in narrow walkways (between buildings) and around the benches and palm trees. With this increase of both types of pedestrians, the pavement space becomes crowded and walking patterns often took sudden and sharp turns and even zigzag movements. One reason was the presence of street vendors and wares displayed by the surrounding shops[69]. The other reason was the pedestrians standing in the middle of the space (Figure 6.40).

  Moreover, the researcher was able to observe the female pedestrians during this period, although their numbers were very limited, in this street. Whenever they were observed, they always kept a distance from male pedestrians or the males were attentive to maintain a distance (Figure 6.41).

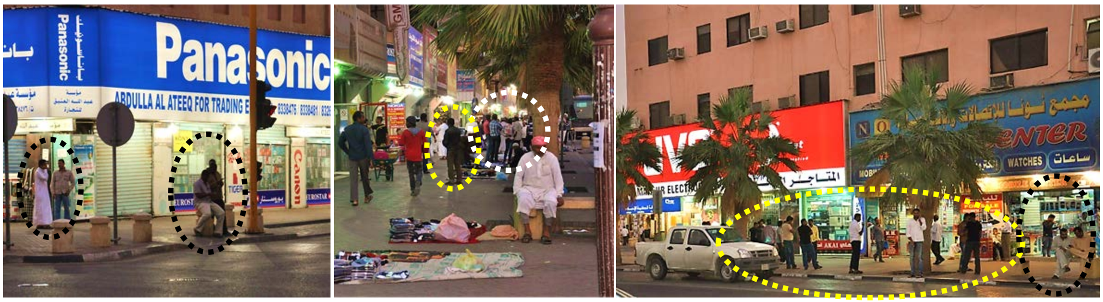


Figure 6.40 Pedestrians most often use the bollards for sitting (left), and stand in the middle of the pavement space (centre) or near the outer edge with their backs to the road (right)

[69] Most shopkeepers tend to display their wares outside their properties, either to prevent street vendors from sitting in front of their shops or for marketing purposes.

Table 6-6 The observed walking patterns and pedestrians' activities in King Saud Street

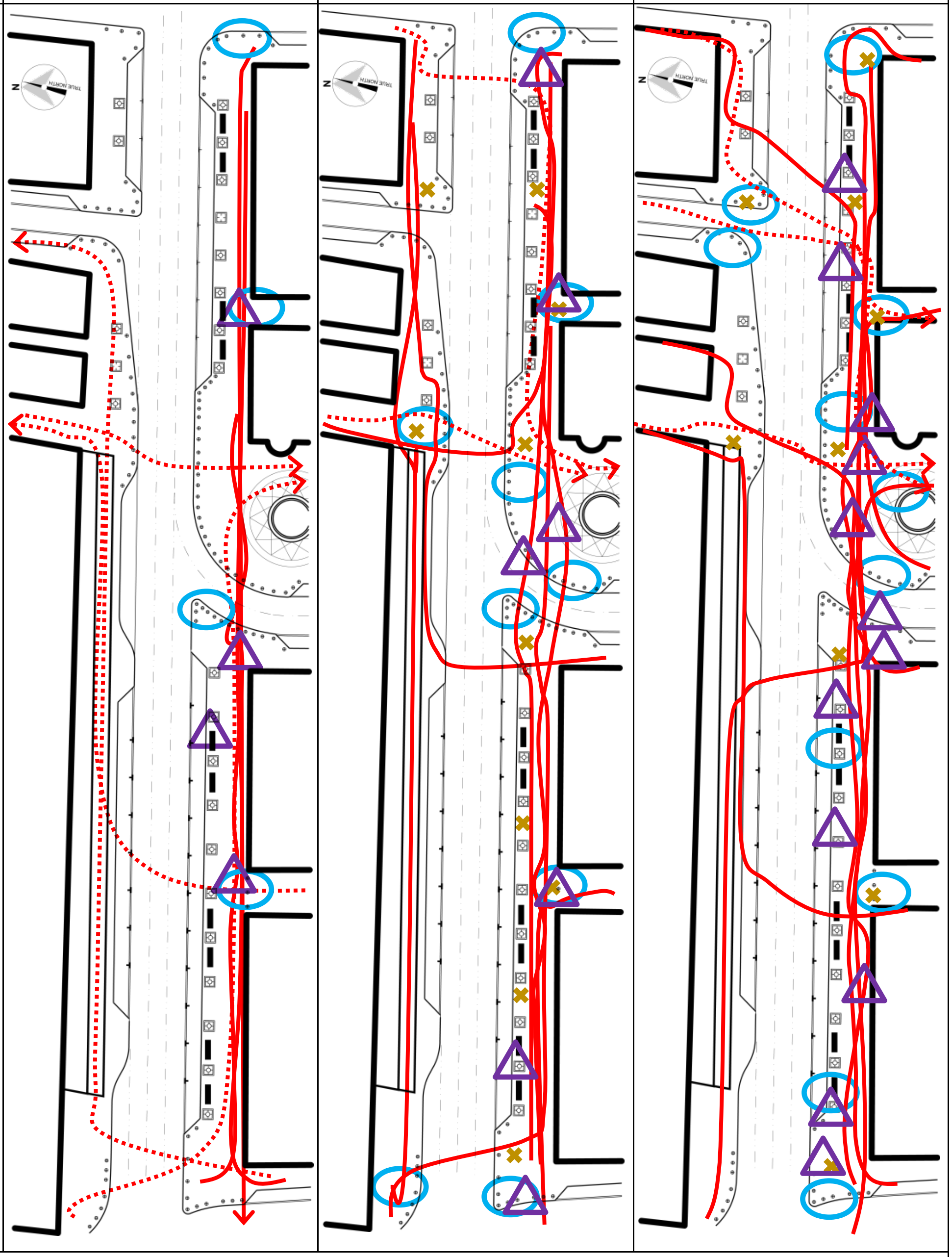
King Saud Street (30m wide)			
Length = 228m x 2-sides | Pavement width (vary): 3–11m			
Observation Days: Wednesday-Friday 2-4 May 2012			
Observation Time:	**4 – 5 PM**	**5 – 6 PM**	**6 – 7 PM**
Avg. weather conditions	Ta = 40.5°C Tg = 41.7°C RH = 14% v = 2.7m/s	Ta = 39.3°C Tg = 41°C RH = 15% v = 1.2m/s	Ta = 37°C Tg = 39.2°C RH = 23% v = 3.4m/s
No. of pedestrians observed	Male: 18	Male: 36	Male: 41
	Female: 0	Female: 0	Female: 7
Walking Patterns and Pedestrians' Activities			
	Transient Walking Standing Area	Continuous Walking Sitting Area	Street Vendors

Figure 6.41 The male/female pedestrians were always observed to keep a distance from the opposite gender

Additionally, it was obvious that the southern side of the street space was more attractive to the pedestrians than the northern side where the add-on arcade was constructed. One reason for this phenomenon, which was also observed in the other observation periods, was the variety of activities on the southern side. Another reason was the relatively narrow walking space on the northern side which became narrower owing to some practices of the shops (Figure 6.42). The other reason was the stored heat in this space, owing to its exposure to the sun most of the day, and lack of air movement.

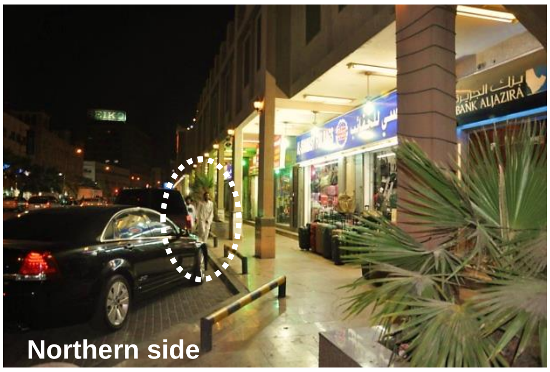


Figure 6.42 Two images, taken at the same time of the same day, for King Saud Street showing that the southern side of the street always becomes denser with pedestrians than the northern side

Furthermore, it was frequently observed that pedestrian crossing was following a chaotic pattern, although this could indicate an even and slow pattern of traffic that was pedestrian-friendly. Besides some attributes related to the pedestrians themselves, the crossing area could hardly be differentiated from the asphalt, owing to the low quality of paving materials used. This was coupled with the lack of signs for the crossing zone, which often forces the pedestrians to cross from any point (Figure 6.43).

Figure 6.43 The low quality of materials used in pedestrian crossing areas often makes the pedestrians cross the road from any point

d) **Physical proximity between pedestrians:** due to the lack of females, observing the theory of proxemics, in this street, was confined to the distances between males only. In general, wherever the pavement was spacious, the pedestrians most often tended to maintain, at least, the far phase (see below) of personal distance from each other (120cm). Nevertheless, this is governed by the weather conditions, on one hand, and width of the pavement and degree of crowding, on the other. Moreover, among the 102 observed pedestrians in this street, personal distance between only 73 men was measured. The reason for this is the exclusion of acquaintances walking together. Although the observed distances were originally measured by ethnicity (i.e. Asian-to-Asian, Arab-to-Arab and Asian-to-Arab), it was considered more pertinent to the focus of this research to be categorised by situation. Hence, two situations were identified, where each situation has close and far phases (Figure 6.44).

- **Walking in the same direction:** the average ***close phase*** of measured personal distance among this group was (***50-80cm***), whereas the average ***far phase*** was (***80-100cm***); both phases include walking side by side or overtaking.
- **Walking in the opposite direction:** this covers two pedestrians approaching each other in opposite directions. The average ***close phase*** of measured personal distance among this group was (***50-100cm***), whereas the average ***far phase*** was (***100-120cm***).

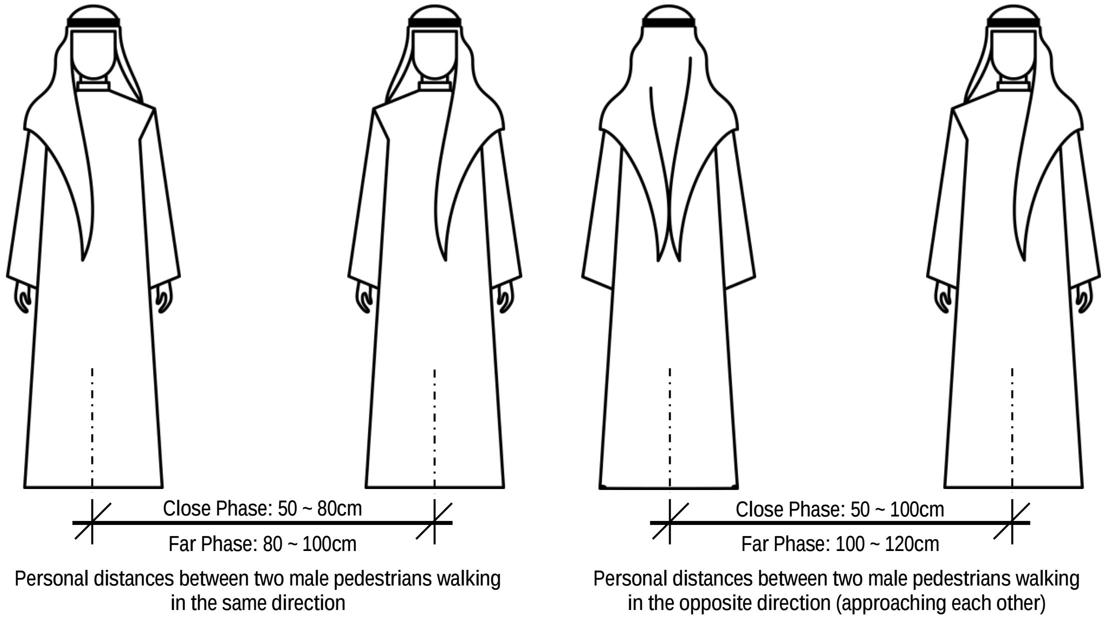


Figure 6.44 Averages of the observed personal distance between strangers (men)

6.3.2 The 13th Street

This was the widest street in the old city fabric as it was the main commercial thoroughfare. Today, the character of the street is dominated by female-oriented commercial activities, and its configuration remains in its original pattern, although most of the buildings overlooking its space have been clad with modern materials. This street varies in width, but generally is categorised as 18m wide with N-S orientation.

6.3.2.1 Part One: the physical and spatial analysis

Figure 6.45 below shows the segment of the street selected for the observation. Similar to the changes witnessed by King Saud Street, as described above, this street has received a large share of attention, physically and spatially:

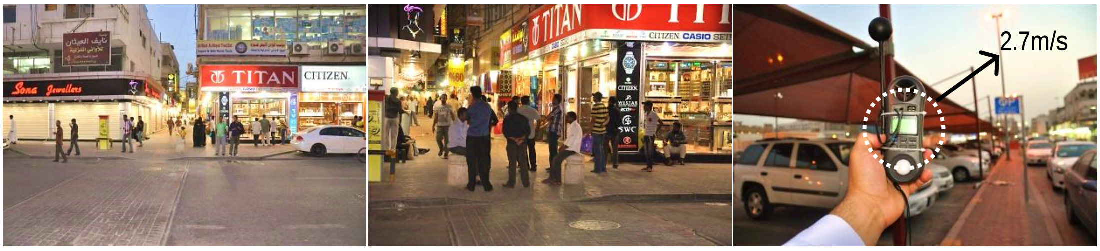
a) The vehicle zone was converted from a two-way street into one-way route, and hence more space was gained to widen the vehicle zone and for incorporating parking lanes;

b) Instead of widening the pavement space, it was narrowed for the incorporation of parking lanes; nevertheless, this process has created areas for pedestrian crossing and tiny squares;

c) Besides the replacement of the standard lighting poles with decorative ones and the alteration of the traditional cement tiles to interlocking pavers, some streetscape elements were incorporated: benches, palm trees and bollards.

Figure 6.45 The physical analysis of the 13th Street

All the side streets at right angles to this street are narrow and differ in width from corner to corner; however, as a general description they vary between 4 to 11m. This compactness is coupled with buildings between 3 to 5-storeys high. Such a configuration creates deep street canyons with an average aspect ratio of buildings' height to street width (H/W) ≥ 2. With the E-W orientation of these streets, the 13th street most often benefits from the generated air movement as a result of this aspect ratio. As a general impression of the researcher in carrying out the observation in this street, the wind speed, particularly at the intersections with these side streets, was observed to be one of most noticeable phenomena creating somewhat a cooling effect, and, thus, the preferred sitting area (Figure 6.46).



Most pedestrians prefer sitting in front of the deep street canyons The opposite side of the street

Figure 6.46 The deep canyon of side streets acts as a wind tunnel which accelerates the wind speed in the space

6.3.2.2 Part Two: the pedestrian analysis

a) **Observation days and Time:** the observation activities for the 13th Street were carried out for three days, from Wednesday 9th May to Friday 11th May 2012, and took place between 4 and 7pm.

b) **Ethnicity and gender:** this street was of a mixed nature of different ethnicity backgrounds of Asians and Arabs, including native Saudis. As expected, the majority of pedestrians were females.

c) Walking patterns and pedestrians' activities: Table 6-7 below shows the summary of observing the pedestrians for three hours on three successive days. The table also describes the average microclimatic conditions recorded during the observations and the number of observed pedestrians, by gender.

- **Period #1 (4-5pm):** the pedestrian traffic was relatively low, and was mostly shopkeepers, hence explaining the small number of female pedestrians. Most of the observed walking patterns were occurring on the west side of the street space. One reason was due to the shaded pavement, and the other because of the parking lot to the back. The sedentary activities (standing and sitting) were typically taking place at street corners on the western side of the street space, and both the bollards and benches were used for sitting (Figure 6.47). Moreover, among the most observed pedestrians' patterns, on the eastern side of the street space, was their walking into the parking lanes. Such behaviour was due to the encroachments by the adjacent shops on the pavement space, thus further narrowing the already narrow pavement (Figure 6.48).

Figure 6.47 Both the bollards and benches, on the western side, were used for sitting

Figure 6.48 The narrow pavement most often becomes narrower owing to the encroachments on its space by adjacent shops, and hence compels the pedestrians to walk into the parking lane

- **Period #2 (5-6pm):** there was a noticeable increase in the number of pedestrians, and women were the dominant group. Among the most frequently observed behaviours during this period was that most pedestrians were committed to using the specified zones for crossing (Figure 6.49). Another observed behaviour was walking in a zigzag pattern. One reason was the interaction with the surrounding activities. The other reason was the illegal use of the pavement space, either by street vendors or shop owners (Figure 6.48), and hence the pedestrians were sometimes forced to walk outward into the parking lanes. Although the sharp turns or zigzag walking patterns may reflect a high flexibility of pedestrian behaviour, they clearly demonstrate a difficult and unfriendly walking environment, in the case of

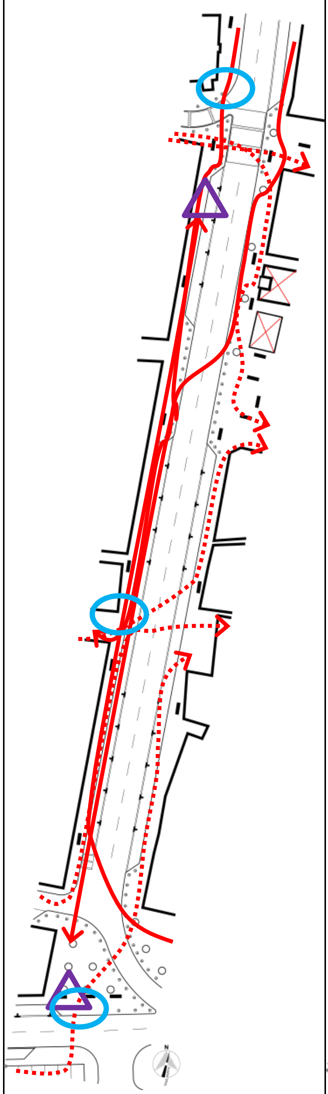
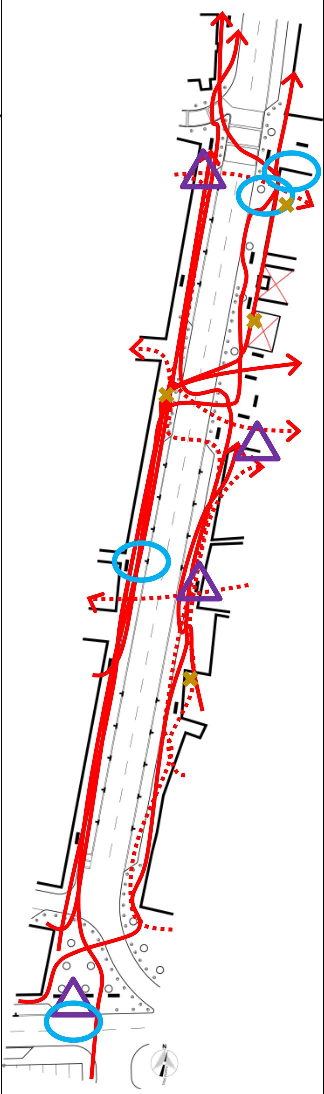
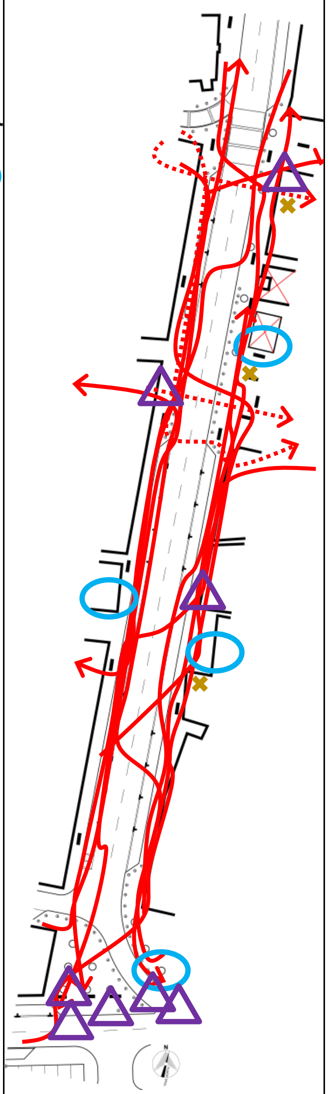
Dammam. Figure 6.50 shows that such a hostile walking environment is most often caused by the wrong placement of streetscape elements.

Figure 6.49 Frequently distributed pedestrian crossing zones foster a smooth walking experience

Figure 6.50 The wrong placement of streetscape elements and/or utilities is most often associated with the zigzag walking pattern along a relatively narrow pavement

- **Period #3 (6-7pm):** this was the beginning of the peak time for pedestrian traffic, for both genders. Walking patterns were very chaotic, where the pedestrians were very often walking onto the road surface. Although this could be positive from a pedestrian perspective, patterns of pedestrian crossing were also chaotic, where the pedestrians, regardless of gender, were frequently observed obstructing cars' movement. The reason for these behaviours was largely associated with the width of pavement space, which was evidently not enough to accommodate all the pedestrians conveniently and simultaneously. Supporting this cause-and-effect relationship was that most of the pedestrians who were observed standing were closer to side streets than the 13th street. Moreover, sitting pedestrians were concentrated in the south part of the street and at narrow paths (deep canyons of the side streets).

Table 6-7 The observed walking patterns and pedestrians' activities in the 13th Street

13th Street (18m wide)			
Length = 231m x 2-sides | Pavement width (vary): 2–3.5m			
Observation Days: Wednesday-Friday 9-11 May 2012			
Observation Time:	**4 – 5 PM**	**5 – 6 PM**	**6 – 7 PM**
Avg. weather conditions	Ta = 38°C Tg = 38.9°C RH = 16.2% V = 3.1m/s	Ta = 36.5°C Tg = 37.7°C RH = 18% V = 2.8m/s	Ta = 34°C Tg = 34.5°C RH = 21% V = 3.4m/s
No. of pedestrians observed	Male: 13	Male: 9	Male: 25
	Female: 3	Female: 17	Female: 29
Walking Patterns and Pedestrians' Activities			
	Transient Walking Standing Area	Continuous Walking Sitting Area	Street Vendors

d) **Physical proximity between pedestrians:** among the 96 observed pedestrians in this street, the personal distance between 81 subjects was measured, including both genders. Thus, observing the theory of proxemics, in this street, was confined to three cases, represented in six situations (Figure 6.51).

- **Personal distances among males:** the average measured personal distance among this group, when walking in the same direction, was (***50-60cm***), whereas the average distance between two men approaching each other was (***60-80cm***). Both situations include walking side by side or overtaking.
- **Personal distances among females:** the average measured personal distance among this group, when walking in the same direction, was ≤ ***50cm***, whereas the average in a situation of two women approaching each other was (***50-60cm***). Both situations include walking side by side or overtaking.
- **Personal distances between male-female:** three situations have been observed where males were: (a) walking in front, (b) walking behind or (c) approaching female pedestrians, but never walking by the side of females. The reason is due to the fact that the covered part of the 13th Street in this research varies between 2 and 3.5m wide. In all cases, it was clear that certain behavioural considerations were maintained. <u>In the first situation</u>, males usually accelerate their walking speed (or women do not tend to increase their walking speed), and hence this can be interpreted as a preference to maintain a comfortable (or even safe) physical proximity. <u>In the second situation</u>, two sub-cases were observed:

  (a) If a male pedestrian has no intention to slow down, he usually steps off the pavement into the parking lane (if was free of cars) or into the vehicle lane. (b) If the male pedestrian has some flexibility, he usually ambles until the pavement space gets wider and then overtakes conveniently. In both cases, this behaviour can be interpreted not only as indicating there is not enough room to allow for a convenient passage for both sexes, but also demonstrating that physical proximity is very pertinent to the use of the pavement, in the Saudi context.

<u>In the third situation</u>, when males are approaching females, they always turn into the edge of the kerb, and even into the parking lane or onto the road surface. This behaviour has three connotations: (a) as a *socio-cultural value*; it means that men are prioritising the passage of females, (b) as an *Islamic guideline*; both genders observe and follow the rule of the avoidance of any form of physical contact with each other, and (c) as an aspect of the *street design*; the physical and spatial conditions of the street space are inconvenient to accommodate both genders simultaneously. However, the average measured personal distances in this third situation, if both sexes were walking in the same direction, was (***100-120cm***), whereas the average distances, if both sexes were approaching each other, was (***80-100cm***).

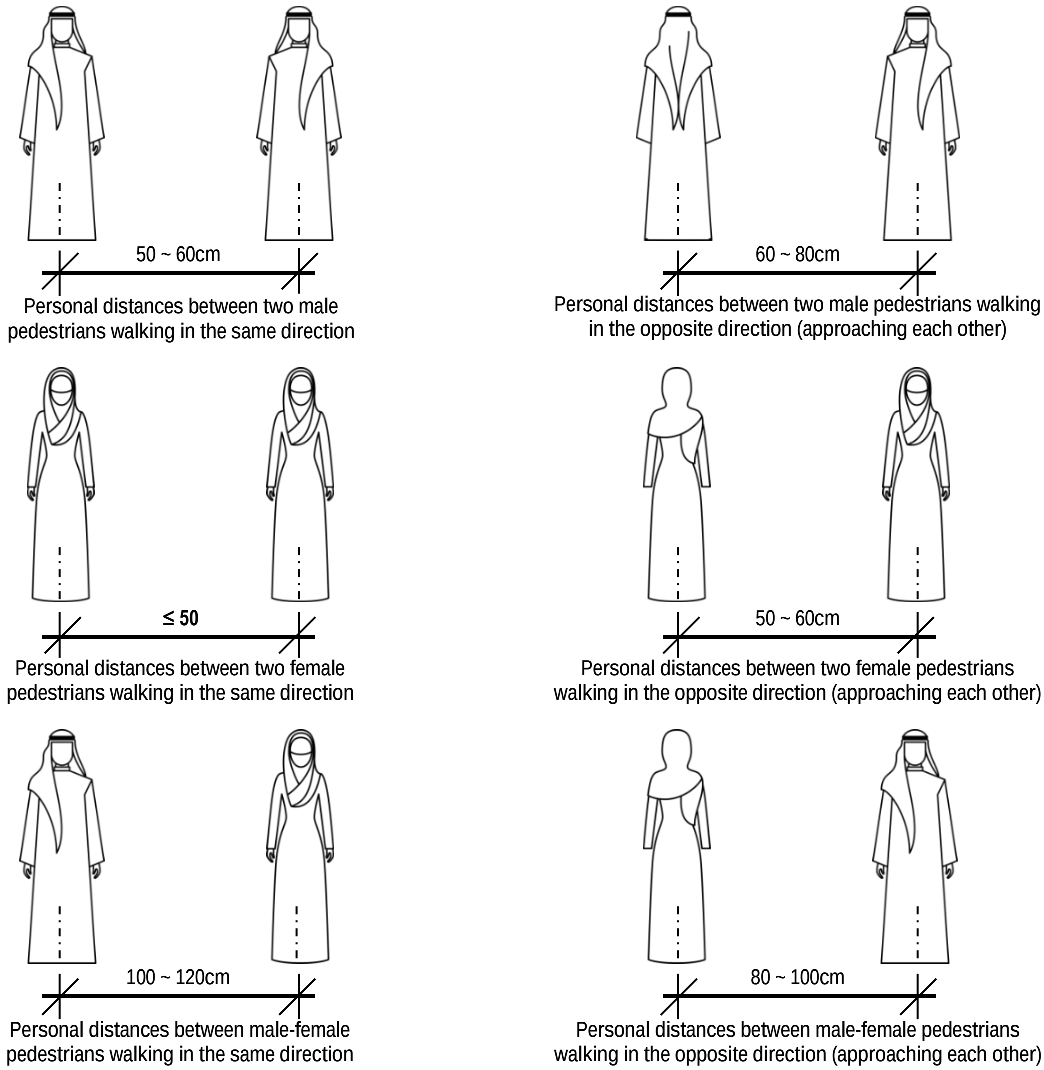


Figure 6.51 Averages of the observed personal distances, by gender, in the 13th Street

6.4 Summary

The findings of the research have identified several aspects related to the perceptions and preferences of the outdoor pedestrians in Saudi Arabia. Most of these aspects were investigated for the first time in the Kingdom, whereas other issues have been explored for the first time in any coastal city. Specifically, the present study defined the upper thermal comfort limit and the environmental factors associated with this thermal boundary for the outdoor pedestrians in Dammam. The upper thermal comfort limit estimated was 31.5°C PET, which equals to 31.1°C Ta, 50% RH, 30.9°C Tg and was associated with an acceptable range of wind velocity between 2.7 and 3.2m/s.

The findings of both methods employed verified that studying the decline of walking rates, in general, and on street, in particular, is better to be approached, simultaneously and collectively, through the proposed conceptual model, in order to restore the pedestrians and their walking activity into the street space. The findings of the interview-based questionnaire revealed that the weight of each of the three components of the proposed model is equally important to the actual pedestrians. The factors under these three components are so intertwined with each other that no specific component is more prominent than the other two in the process of an individual's choice to walk.

The findings of the observation activities reaffirmed the dual impact of key street characteristics on pedestrians' reluctance to walk on streets. Thus, urban designers and landscape architects are highly advised to pay careful attention to two levels of simultaneous interventions: physical and spatial, including streetscape elements, in order to attain ***comfort, quality and safety***, collectively. The observational records also confirmed that shading and wind velocity are primary factors associated with outdoor thermal comfort, in Dammam. Both variables were clearly specified based on observing where the pedestrians preferred to sit and stand, at three different times.

Drawing on the research findings of both methods presented in this chapter, the following chapter discusses only the key findings and presents the conclusions reached.

Chapter Seven: Discussion and Conclusions

"Present-day urban development is ruined, most often, by the hierarchy of decisions in which the road network comes first, buildings come second, and pedestrian space comes third. The correct sequence is just the opposite: pedestrian space first, buildings second, and road third" (Alexander et al., 1987: 74-75)

7.1 Introduction

The previous chapter presented the findings obtained from separately analysing the collected data by interviewing and observing the pedestrians in their actual walking environments. This chapter discusses and interprets collectively the key findings obtained from each data collection method, combined with the analysis of the physical and spatial characteristics of the existing street conditions described in Chapter Four. The aim of this chapter is to answer the main research question:

> How can the neglected street space be reclaimed to restore walking under hot-humid climatic conditions with certain outdoor socio-cultural requirements, in order to inform decision-making into improved street design?

This chapter also addresses the recommendations for improved street design to restore walking into the street space in Dammam and other Saudi coastal cities and ends with the research's key conclusions and areas for future research"

7.2 Discussion

The analysis of the findings has confirmed some of the initial postulates; at the same time, it has contradicted others while revealing some new findings. The discussion takes the key findings from both methods employed and compares them with the findings from the literature review.

7.2.1 Outdoor thermal comfort in Dammam City

The subjective thermal comfort study was carried out under temperate climatic conditions of spring, from end-April to end-May 2012. There were 244 interviewees from eight outdoor sites in this study, through a questionnaire. The analysis of the thermal sensations and preferences of outdoor pedestrians revealed that the pedestrians were affected by a number of physiological factors, including thermal experience, expectation and duration of exposure, but mostly by the thermal conditions and the availability of shading in the outdoor spaces. Interviews carried out in sunlit locations were found to be extremely uncomfortable. Thus, the typical time for outdoor pedestrians, in all available walking spaces in Dammam, was late afternoon, to benefit from the shaded conditions, as frequently observed in a number of situations in this thesis.

The calculated upper thermal comfort limit of outdoor pedestrians was found to be 31.5°C PET (Figure 6.31). According to the linear regression model that was generated between the PET and the air temperature (Ta), globe temperature (Tg) and relative humidity (RH) (Figures 6.32-6.34 and Table 6-4), the estimated upper thermal comfort limit was associated with Ta equal to 31.1°C, 50% RH and 30.9°C Tg.

The upper comfort limit defined for Dammam, in this research, was significantly different from the corresponding ones obtained in other selected climates. For instance, the upper comfort limit in the ***temperate*** climate of Central/Western Europe was found to be 23°C PET (Matzarakis & Mayer, 1996), in ***subtropical*** Sydney Australia was 24.8°C PET (Spagnolo, & de Dear, 2003) and in ***hot-arid*** Riyadh Saudi Arabia was 38.8°C PET (Alznafer, 2014). However, it was slightly above the corresponding ones obtained in similar ***hot-humid*** regions, such as in Taiwan, where it was 30°C PET (Lin & Matzarakis, 2008), 28.5°C PET (Lin, 2009), and 29.4°C PET in south Taiwan (Lin et al., 2013), while it was 30°C PET in a coastal city in Brazil (Algeciras et al., 2015; da Silva & de Alvarez, 2015). Nevertheless, the finding of the present study was almost identical to that found in Singapore: 31.7°C (Yang et al., 2013).

The reason for such variations in the PET values found in this research can be attributed to the fact that outdoor users, in severely hot climates, are more likely to be physiologically adapted to high climatic conditions and have a high degree of control over a source of discomfort (Nikolopoulou & Steemers 2003; Brager & de Dear, 2003). This echoes the finding that when the air is humid, a temperature of around 30°C can feel unbearable (Szokolay, 1980; Beer & Higgins, 2005). Additionally, these variations indicate that outdoor users in different climatic regions, and even in the same climate conditions, have different thermal requirements (da Silva & de Alvarez, 2015).

7.2.1.1 The significance of wind velocity to the outdoor thermal comfort in Dammam

Although the wind velocity showed weak correlation with the PET (R^2 = 0.0263), the upper thermal comfort limit was mostly associated with an acceptable range of wind velocity between 2.7 and 3.2m/s. The reason for this weak relationship can be attributed to the constant change of wind velocity, during the time of the interviews, and, hence, clear fluctuation in the measured v values (Figure 6.35). This may justify the preference of the majority of the participants for more air movement (63.9%) and less humidity (66.4%) (Figure 6.13).

This acceptable range of wind velocity is relatively higher than the preferred upper wind speed (2.9m/s) determined in spring in recent research for a hot-humid coastal city in Brazil (Da Silva & de Alvarez, 2015). The present study corroborates previous studies which showed the wind velocity is a major player affecting outdoor thermal comfort in such a climatic context. This is due to the cooling effect of air movement to mitigate the impact of humidity, and to offset the high air and globe temperatures, and hence mean radiant temperature (e.g. Johansson & Emmanuel, 2006; Ng & Cheng, 2012). However, there is one downside of this relatively high wind speed, in such a desert region. Natural high wind speeds most often bring dust into urban areas, and thus are not always appreciated.

Moreover, as well as the impact of the physical and spatial deficiencies of the street space in pushing pedestrians to other urban places, it was frequently observed that most of the pedestrians went to, for example, walking tracks and the Corniche area, owing to the lack of thermal comfort within the urban setting. Both of these urban spaces are located in an open space where the surrounding neighbourhoods are relatively distant. The point to be discussed here is that under a hot and humid urban environment, like that of the city of Dammam, air movement is a crucial factor significantly associated with attaining outdoor thermal comfort. Accordingly, pedestrians' preferences to walk in such places can be highly supported by the observed higher wind velocity compared to the relatively low air movement within urban neighbourhoods.

Additionally, the duration of exposure to heat stress in Dammam is often extended to include night-time, mainly due to the retained heat in the urban surfaces which is released to the lower urban atmosphere, or the so called the urban canopy layer (UCL), which eventually makes pedestrians more vulnerable to heat stress and more concerned about their thermal comfort in urban spaces. In Dammam, where the hot and humid conditions are acute (Table 4-1 and Figure 4.15), the effect of wind velocity is significantly large; thus, air movement is a necessity to enhance conditions of thermal comfort in the outdoor environment (Murakami et al., 1999; Erell et al., 2011a; Szokolay, 2014).

This need for air movement becomes of great importance owing to the low wind velocity in the urban spaces of Dammam, and it is therefore rational to employ active methods to provide an acceptable ambience outdoors. Hence, it is highly recommended to incorporate the concept of urban wind towers at street level where they can have a dual impact on pedestrians' thermal comfort. On one hand, they help to increase the relatively low wind velocity at pedestrian level within the urban setting. On the other hand, they contribute to mitigating the heat stress in outdoor spaces caused by the combined effect of high air temperatures and high levels of relative humidity, particularly, during the spring and summer seasons, where the intense solar radiation, and hence Tg, is usually combined with high diurnal and nocturnal air temperatures.

Figures 3.24 and 3.27 show the unique design of wind towers constructed in Masdar City near Abu Dhabi, and at Clarke Quay near the mouth of the Singapore River (see Chapter Three, section 3.3.8). Both sites are influenced by hot and humid conditions, and such design interventions have succeeded in providing thermally comfortable outdoor spaces. This was achieved by the remarkable decrease in the Tmrt and the mitigation of the impact of high RH rates, as a result of increasing the wind velocity at pedestrian level. Such a design solution can be incorporated into the existing condition of the street space in Dammam, and hence is anticipated to make a difference to encourage walking on the streets.

7.2.1.2 The significance of street shading

Although designers' ability to control outdoor air temperature maybe very limited, it can be fairly simple to control exposure to the sun (Erell et al., 2011a). With unbroken sunshine for most of the year in Dammam, nothing is more important to the pedestrians' thermal comfort than the crucial need to provide protection from solar radiation. Thus, shading streets is far beyond being just a supplementary requirement to restore the pedestrians into the street space in Dammam; whether natural or man-made, it will promote radiative cooling that eventually affects the experience of pedestrians' thermal sensations (Nikolopoulou, 2004; Lin et al., 2010; Alznafer, 2014).

Proceeding from the focus of attention of this research on restoring the pedestrians into the existing streets, coupled with the need to maintain easy flow of air movement into streets (Turner, 1996; Nikolopoulou et al., 2001), the optimal approach is to implement alterations at the microscale of the street space to improve the microclimate (Gehl, 2010; Erell et al., 2011a). Accordingly, providing improved shading solutions, mainly through the integration of trees and light shading canopies, into streets, including pavements, is feasible and effective to reduce the impact of solar radiation. The literature review (see Chapter Three, section 3.3.8) revealed several practical shading techniques that are currently utilised in hot regions, which can be incorporated into the existing condition of the street space in Dammam.

Several researchers emphasised how effective is the impact of shading by trees on thermal conditions at pedestrian level and, consequently, on the human thermal comfort (e.g. Lin et al., 2010; Shashua-Bar et al., 2011; Lin et al., 2013). Although the optimal location of trees within the street space depends on street orientation and street aspect ratio (Toudert & Mayer, 2006), it has been acknowledged that more than one row on the pavements is recommended (Al-Awais, 1991; Sheets & Manzer, 1991; Konarska et al., 2014). However, combining a variety of shading elements has been established to be more efficient to increase the shading quality, not only by reducing the direct exposure of pedestrians to solar radiation, but also by reducing surface temperatures. Consequently, urban microclimatic conditions are highly subjected to improvement, and correspondingly, pedestrians' thermal comfort (Erell et al., 2011b).

7.2.2 The influence of the street design on personal distance

Generally, the findings from both methods have revealed that walking as a physical activity and behaviour, and hence as a lifestyle, is socio-culturally governed. This finding corroborates what Rapoport (1991), BaHammam (1995), Sarkar (2003) and Nicol et al. (2012) described in the literature. Derived from the discussion of these sources, the research findings confirmed that the use of streets by pedestrians is influenced by climatic, social and cultural context, as well as the quality of the street space. Because walking quality on streets requires comfort conditions at physical, physiological and psychological levels, which vary spatially and culturally.

Among the most significant and sensitive socio-cultural aspects found to be associated with the pedestrians' withdrawal from the street space is the inability of urban streets to provide a comfortable personal distance (***proxemics theory***) between pedestrians, particularly between the opposite genders. Proxemics is among the spatial behaviour theories associated with interpersonal spatial relationships and the influential role of an individual's socio-cultural aspects in relation to the physical environment. The findings of the interview-based questionnaire revealed that almost 71% of the interviewees agreed that the personal proximity to other people has a strong impact on their withdrawal from using the urban streets (Figure 6.19). Among this segment, the female group was the majority (94.5%) compared to about 61% males. Moreover, 41.4% of the sample (1/3 males and 2/3 females) prefer an interpersonal distance between 1.5 and 2m when walking from other pedestrians. This was followed by 20.1% who preferred 1.2-1.5m (Figure 6.20).

Supporting these findings, observation of the pedestrians in the actual street space revealed that the spatial characteristics of the pavements play an influential role on the use of the street space, for walking, and hence the preferred personal distance. For example, observing the pedestrians in King Saud Street (Figure 6.44), which has a wide pavement space (3-11m), showed that the average physical proximity during walking was between 1.0 and 1.2m, although this average was measured between males only. This was also the average preferred physical proximity between the opposite sexes measured in the 13th street.

According to Namazian and Mehdipour (2013), studying proxemics and its relationship to the built environment is becoming increasingly popular, particularly in Muslim societies (BaHammam, 1995; Al-Abdullah, 1998; BaHammam, 2006). In this context, the analysis of the actual measurements of the physical and spatial characteristics of urban streets in Dammam (Table 4-5) revealed that the average width of pavements varies between 2.2 and 2.8m. Thus, it can be clearly said that the existing pavements are generally too narrow to accommodate the preferred personal distance, taking into account the need to incorporate other facilitating conditions to support walking, namely, streetscape elements and shading techniques. Supporting this finding is the observation finding of the 13th street, which confirmed that whenever a part of the pavement is ≤ 2m wide, and when some encroachments are sharing a part of the space, the pedestrians very often walk into the parking lane, if no cars are parked and even into the car lane. This hidden dimension has been found to be one of the contributing factors explaining the cause-and-effect relationship between street design and the decline of walking rates on streets, in the Saudi context, especially when both sexes are expected to use the street space, simultaneously.

7.2.3 The influence of the quality of the physical & spatial characteristics of the street space on walking

Supporting the preliminary finding in Chapter Four (see section 4.5), analysis of the subjective responses reconfirmed that the physical and spatial characteristics of the existing street space in Dammam have contributed in the failure for retaining much or any user-friendliness for walking or for sustaining street life. Street design neither responds to the prevailing climate conditions, and hence lacks to necessary measures that are climatically responsive, nor considers the relevance and impact of the personal distance on the use of urban streets for walking. Eventually, pavements are too narrow to respond to such required qualities to restore the pedestrians and walking, as a lifestyle, into the street space.

However, the observations carried out in King Saud Street revealed that the wide pavements per se, without the incorporation of climate-responsive design solutions, do not help to encourage walking. The findings of the present study corroborate the thesis that pedestrians always appreciate noticeable differences, complexity and quality of surrounding details. This is due to their low speed of movement and close distance to objects, on one hand, and the multi-sensory experience which walking provides to the pedestrian, on the other hand.

Restoring the pedestrians into the street space has been possible to attain in many parts of the world, mainly by concentration on the characteristics of this space; physically, spatially and thermally, at eye level, as experienced by the actual pedestrian. For this, several environmental quality requirements are necessary and recommended for encouraging the pedestrians to enjoy the walking experience and stay longer in the street space. Specifically, more attention in street design needs to be given to the quality of design details, safety measures, increase in urban trees, width of pavements and adopting climatically responsive urban design strategies.

Moreover, although the research findings have confirmed some of the initial postulates and corroborated previous findings, they have contradicted others. The findings of the research showed disagreement with some of the previously accepted claims. For example, Gehl (2011) asserts that walking, as a necessary activity, occurs regardless of the quality of the physical environment, because pedestrians are compelled to carry it out. The present study showed that quality of the street design, mainly through the physical and spatial characteristics, is necessary to encourage walking; otherwise pedestrians would continue driving to other urban destinations to walk. This includes the capability of the street space to provide a better quality of thermal environment, and to respond to the requirements of local socio-cultural aspects of the pedestrians.

Both data collection methods employed in this research demonstrated that walking on streets is largely affected by the physical and spatial characteristics of the street space, because, at the microscale of the street space, the pedestrians can feel invited or discarded, and hence walking can be practically facilitated or impeded. At this scale is where appropriate and promising design interventions can be incorporated into the existing conditions so as to contribute towards encouraging the use of streets for walking.

Thus, it can be clearly concluded that restoring the pedestrians into the street space is a complex issue, owing to multifaceted nature of the factors affecting an individual's choice to walk. In fact, any single improvement to the street space may respond to a part of the problem but would not be enough to cover the major dimensions associated with the pedestrians' reluctance to use urban streets for walking. Streets need to change and evolve to satisfy the pedestrians' needs, which evolve over time as well. Thus, appropriate design interventions, physically and spatially, and hence thermally, at the microscale of the street space would be rational to satisfy the pedestrians' needs, as explored in this research.

7.2.4 Improved street design

This research has contributed to broaden the understanding of the pedestrians' requirements, attitudes and preferences, in order to identify ways in which the neglected street space can be reclaimed to restore walking under hot-humid climatic conditions, and for a society with certain socio-cultural requirements. Thus, to achieve improved street design in order to restore walking, the study informs decision-making by recommending to widen the existing pavement space. This widening approach is essential (a) for incorporating physical design interventions, including appropriate streetscape elements and the integration of multiple urban microclimate improvement methods, mainly based on the combined effect of shade (to reduce the effect of solar radiation) and ventilation (to mitigate humidity), and (b) for satisfying the average personal comfort distance between pedestrians.

The space required for this new spatial configuration can be gained by redistributing the street space away from cars and towards pedestrians, or the so called "rightsizing streets". Specifically, the analysis of the spatial characteristics of the existing streets in Dammam, carried out in Chapter Four (Table 4-5), revealed that the actual width for the vehicle lane ranges between 3.6 and 3.8m, whereas the average parking lane width ranges between 2.7 and 4m. According to the AASHTO's standards (2011), which the KSA has adopted for the design of its urban streets, a typical traffic lane width varies from 3.0-3.6m, although 3.6m is most desirable for major arterials with high speed and free-flowing traffic.

With these criteria in mind, and referring back to Figure 4.22, the major arterial is a very limited street type in Dammam, thus traffic lanes ≥ 3.6m are most likely to be unnecessary. Supporting this claim, 3m traffic lane width is normally quite adequate for signalized streets at 70-80km/h (AASHTO, 2011), which are exactly the existing conditions in all main streets in Dammam. Thus, it is clear that the urban streets in the Kingdom are applying the highway standards or the maximum values recommended by AASHTO; more priorities are given to the car and traffic at the expense of the pedestrians and pavements. When the vehicle zone, including traffic and parking lanes, is built too wide, pedestrians are often forced to walk further across streets on which cars are typically moving too fast.

Moreover, according to AASHTO (2011), the standard width of parallel parking lanes ranges between 3.0 to 3.6m, although reducing width of this space to 2.1-2.4m remains quite adequate in all street types except arterial roads. Moreover, AASHTO's standards plainly point out that the use of the maximum values should be carefully considered, and only when applied the social and environmental impacts are not critical. In other words, AASHTO emphasises the need to take into account the role of the local context in encouraging independent designs tailored to local situations and settings. These are the matters that this research has proved to be critical and which play an influential role on the pedestrians' withdrawal from the street space into other urban places for walking.

Given the information discussed above, it is very easy to rebut any argument against narrowing lane widths in the vehicle zone. Accordingly, a lane width of 3m for both the traffic and parking should be considered as most desirable within urban streets, if accommodating the pedestrians is regarded as significant social, environmental and health issues. Thus, the concept of redistributing the street space emerges as a rational and effective design solution to restore the pedestrians into this space. Accordingly, rightsizing streets, including the pavement space, serves three major functions: (1) to accommodate the necessary climatic-responsive design interventions so as to modify the microclimate and thus provide better thermal conditions for pedestrians; (2) to incorporate streetscape elements to facilitate the pedestrians' movement, enhance the walking experience both functionally and visually (aesthetically) and eventually to encourage extending the length of use of the space, and (3) to satisfy the pedestrians' spatial behaviour, which is being largely influenced by certain socio-cultural aspects.

This conclusion corroborates previous studies, e.g. those by Alexander et al. (1987) and Topp (1989), which demonstrate that reduction of the width of the street space, through narrowing both the vehicle and parking lanes, widening the pavement space and planting of trees, not only reduces car speeds and separates pedestrian traffic from vehicles traffic, but also produces more justice in the division of the street space.

7.3 Recommendations

Through the analysis of the physical and spatial characteristics of streets and the observation activities carried out in King Saud Street, it was very clear that pavements located on the north side of E-W oriented streets are recommended to be designed differently. The pavements on this side of the street, i.e. facing south, need to be wider than those located on the southern side. This suggested increase of width becomes essential to enable incorporating dense shading elements, whether natural or man-made, due to the long exposure of surfaces on that side to direct solar radiation during most of the daylight hours.

Combined with ease of applicability of this design solution to the existing conditions, this would be also compatible with regulations of building heights in Saudi Arabia; namely, three-storeys for residential buildings, five-storeys for commercial and over that for buildings with mixed-use or office functions. The main point here is that reliance on street geometry, particularly the building height to street width aspect ratio (H/W), as a suitable intervention for providing shade is not always an available solution with the existing building regulations, taking into account that street spaces need to accommodate cars. Thus, it would be more sensible for these types of pavements to be wider to incorporate appropriate shading and streetscape elements.

Moreover, the findings of the questionnaire and observations revealed the dual impact of key street characteristics on pedestrians' reluctance to walk on streets and this led to two levels of simultaneous interventions being suggested: physical and spatial. In this regard, marking the pavement to indicate distance walked along with high quality streetscape elements was shown to attract pedestrians effectively.

7.4 Limitations of the study

7.4.1 General limitations of the research findings

The findings of the present study were exclusively obtained from a particular case study (Dammam, Saudi Arabia), though other contexts, mainly those located within the Gulf countries, may benefit from such findings, due to their similarity in certain socio-cultural values and environmental conditions. However, it is highly advised for future studies interested in a similar research project, particularly those that will be carried out in settings experiencing hot and humid conditions, to carefully assess, or consider with precautions, the potential transferability and appropriateness of the findings for their own settings. This is due to the fact that the research findings were deeply influenced by local conditions, mainly socio-cultural aspects; whether on the level of traditional clothing, and thus the state of thermal comfort, or on a behavioural level that largely governs and guides interpersonal interactions, owing to the impact of Islamic teachings.

Regarding the questionnaire, most of the data obtained through this quantitative method were not normally distributed, being mostly positively skewed. Although such positivity was cautiously interpreted as a collective agreement of the participants towards the questions posed, other statistical analyses could have been used to analyse this type of distribution, by statistically transforming data to become normally distributed.

The quasi-experimental method of the participant observation was done with a relatively a very small number of pedestrians. Ideally, more observations should have been conducted in the two selected streets, or even including other streets, to validate the findings and make them more robust and reliable. Another associated challenge was the fact that this method was conducted in May; when the climatic conditions typically begin to be severe. Thus, perhaps if it had been carried out in other seasons, and even in all the available walking environments, it would have contributed to more representative findings.

Although the repeated observation of certain variables and findings, across the two methods adopted, has contributed to validating and building an evidence base, both the descriptive and statistical findings should be also interpreted with caution. This is because both the sample sizes of the participants in the questionnaire and those who were observed were relatively small. Hence, larger samples would have arguably contributed to more solid relevant evidential research; therefore, generalisations have been made with caveats. In addition, the nature of the current collected data suggests that the interpretation of results should be limited to the samples of participants examined at the time of this research.

7.4.2 Limitations of the questionnaire

Despite the fact that the design of the questions in the final version of the questionnaire was subjected to very extensive development, two key challenges that the author has encountered during this learning experience need to be highlighted here as limitations to be considered in further research.

a) It has been already mentioned several times throughout the thesis no preceding similar study has been conducted, at least in the Arab region, that focuses on integrating three influential factors connected to restoring walking into the street space in a single study. That was coupled with the need for several aspects, under each one of the three factors, to be measured simultaneously *in situ*, which would eventually feed into answering the main research question. Focusing on these combined reasons inevitably contributed to drawing the attention of the author away from considering properly the application of the questionnaire method outdoors, in terms of leading him to produce a very detailed questionnaire that may be considered as relatively "lengthy".

   Although it has been argued that the face-to-face situation may allow for the questionnaire to be extended (Bernard, 2006; Neuman, 2014), the author acknowledges here that answering a long questionnaire, particularly under hot-humid climatic conditions, may have potentially affected the participants' answers and thus the quality of some of the findings. For example, the number of questions posed may have potentially contributed to make some participants inclined to give less careful answers by continuously ticking the same side of the column (boxes) that might not really reflect their true answers because of the time it required or their wish to continue with their own activities. Therefore, it is highly recommended for future studies that, in order to avoid automatic or unconsidered responses, the order of the scale, or the style of gauging the answers, should be altered for some questions.

b) The observations and outcomes obtained from pretesting and piloting the first and amended drafts revealed that the participants in that sample preferred direct questions and very often demanded additional examples or clarifications. Therefore, the final design of the questionnaire witnessed re-wording and paraphrasing processes, several times, not only to fulfil the proposed guidelines (see section 5.6.3), but also owing to the lack of equivalent Arabic words or even direct translation for several English technical terms used frequently in this research area (e.g. pedestrianisation). Thus, these factors contributed to the formation of rather “complex” and “leading” questions, despite the researcher’s best intentions and efforts to simplify the wordings of the questions, and to achieve neutrality.

   This does not mean that the researcher did not think long and hard about the questions, or that they are inappropriate. However, the author acknowledges that some of the questions, as frequently highlighted during piloting the questionnaire, were asked in a less appropriate way, where they were biased towards, or influenced by, certain perspectives. This can be observed in some questions, mainly in part IV of the questionnaire, which focused on measuring the participants’ subjective evaluation of the relationship between the existing conditions of selected attributes of street design (physically and spatially) and the pedestrians’ withdrawal from the street space, and hence may have potentially influenced the interpretation of the findings. With hindsight, such questions could have been better worded, refined and structured to avoid leading the interviewees, and it would be better to pose more indirect or open-ended questions, if future research was carried out.

Therefore, it is highly recommended for researchers in future studies to thoroughly reconsider their questions to avoid such limitations, especially if they take the form of stating or describing an existing problem directly, as was the case for questions in part IV. Additionally, the author suggests that integrating an advanced statistical method, such as the Factor Analysis[70], could have increased the scope and depth of the findings, and could potentially overcome the occurrence of such limitations in future studies.

7.4.3 Limitations of the environmental monitoring equipment

Since the majority of the interviews took place at evening times and sometimes just before sunset, during which the intensity of solar radiation was at its lowest, the findings related to the pedestrians' thermal comfort can be considered acceptable. Nevertheless, one of the limitations associated with such findings in the present study is the use of the handheld monitoring device.

a) On the one hand, the constructed matt black globe thermometer attached to the device for measuring the globe temperature (Tg) needs to be reconsidered. Using the black globe thermometer without correction for, or taking into account, the absorptivity of the clothing worn assumes that all people are wearing black clothing and have dark skin, in the case of exposure to short-wave radiation (e.g. the sun). This tends to overestimate the influence of short-wave radiation, thus overestimating the mean radiant temperature (Tmrt) (Nikolopoulou and Lykoudis, 2006). Although the thermometer was made and adopted according to similar previous studies (e.g. Ng & Cheng, 2012; Cheng et al., 2012; Alznafer, 2014; Tan, Lau & Ng, 2016), it should have been replaced with a matt grey globe thermometer. Therefore, the author acknowledges here that, since the time when the data was collected and the results analysed, the matt grey colour for globe thermometers, instead of black, has been recommended for outdoor environments. This is because it can better represent the outer surface of a

[70] The Factor Analysis is a data reduction technique usually utilised to simplify a large series of data by organising it into smaller groups of independent factors. Due to its explorative nature, it would be an effective analytical tool to provide a better understanding of the latent variables of the collected data, by means of clustering of preferences and perceptions (answers), to be meaningfully interpreted based on correlation with each other.

clothed person, particularly when exposed to solar radiation (ISO 7726, 1998; ASHRAE, 2009; Johansson, 2016). Importantly, using the matt grey globe thermometer, as has been done in several outdoor studies (e.g. Thorsson et al., 2007; Aljawabra & Nikolopoulou, 2010; Tan et al., 2013; Yahia & Johansson, 2013; Hirashima et al., 2016), has been shown to provide better accuracy in measuring the Tg, and hence more reliable estimations of the Tmrt. Particularly, in the limited cases in this research where the interviews were conducted under the shade of a surrounding building (see section 5.6.4), the measured values of the Tg may not be as reliable as they would have been if measured with a matt grey globe thermometer.

b) In addition, the built-in anemometer needs to be reconsidered, as it is limited to one directional air flow measurement. During the interviews, there was a need for a constant orientation of the device towards the wind direction, which, if not maintained, may reduce the sensitivity to wind speed variations. Nevertheless, even though several readings were taken to calculate the average wind speed to overcome this issue, there was a potential limitation on wind speed measurements from various directions. Because wind speed measurements were carried out by holding the device approximately at a height of 1.1m above ground level, this may have potentially contributed to block the air movement, whether by the researcher or participant.

   It is suggested for further research to be conducted to consider other types of anemometers (e.g. omni-directional) that would be able to measure any wind directions, as this could improve the certainty and reliability of wind speed measurements. However, researchers would be advised to carefully observe limitations of other anemometers for outdoor use. For example, Johansson (2016) stated that three-cup and propeller anemometers may not be appropriate if low wind speeds are expected, due to, for example, the impact of urban configurations.

7.5 Conclusion

It is evident that what makes any city a vibrant place is the presence of people outdoors where they can practise their daily activities freely and conveniently anywhere at any time. Certainly, there is no better public urban space where one can feel this vitality than streets. Urban streets are neither merely arteries connecting different parts of the city nor solely movement channels. Streets are public places that should fulfil the needs, desires and expectations of all types of users.

Thus, when street design has become monofunctional, and biased in favour movement of cars and prioritise driving at the expense of walking and pedestrian space; streets have become deficient and failed to retain much or any user-friendliness for walking or for sustaining street life, at large. In Saudi Arabia, probably more than anywhere else, at least in the Gulf region, almost all streets, apart from those in the two holy cities, are experiencing a loss of vibrancy owing to the lack of pedestrians, while the culture of car dependency is growing with an unprecedented consistency. Such a priority and constant concentration on the motorists' needs has compressed the dedicated space for the pedestrians and has neglected to understand the required components to foster walking. Eventually, the pedestrians have been pushed outside the street space.

Correspondingly, a better quality of outdoor lifestyle for the dwellers on foot is degraded and neglected. Therefore, this increasingly sedentary lifestyle is leading to significant health problems and occurrence of lifestyle diseases, mainly due to the declining rates of walking. Nevertheless, other urban places are simultaneously witnessing the increase of walking rates and attracting numbers of pedestrians.

The lessons learned from other contexts, as discussed in Chapter Three, need to be combined with socio-cultural studies of any local city, to produce an appropriate model for the street reform of a city. Although the transformation of a city to be more pedestrian-friendly, and the process of revitalising urban streets for walking have increasingly become a global trend since the late 20^{th} century, it is still an underestimated goal or peripheral vision in the urban design of Dammam and other Saudi cities.

The present study has investigated Dammam as a case study, through several walking environments, to delineate the appropriate design interventions that are compatible with certain socio-cultural aspects of the pedestrians and responsive to provide outdoor thermal comfort. A preliminary review of previous studies and common theories related to both the urban environment and behaviour change, carried out in Chapter Two, showed there is a lack of agreed-upon models that provide a complete framework for understanding and assessing the link between the urban environment and physical activity. Until now, a holistic theoretical framework for research into restoring walking into the street space, as a better quality of lifestyle, has not been specifically elaborated. Therefore, studying the cause-and-effect relationship between street design and walking is challenging, owing to the multifaceted nature of the factors affecting an individual's choice to walk, and the evidence has demonstrated that it should be locally context-sensitive, particularly when the existing practices of street design combined with environmental conditions represent discouraging factors towards walking.

Thus, the study developed a conceptual framework comprised of three influential factors: street characteristics, pedestrians' socio-cultural aspects, including behaviour, and urban microclimate. The integration of the proposed components proved to provide the best approach to tackle the research problem, in a hot climate with a Muslim society. It demonstrated the need to study these components collectively, if restoring the pedestrians into the street space is the aim.

Through the simultaneous understanding of the three components of the proposed conceptual model, this research has contributed to extending the understanding, deepen the discussion and enriching the analysis focused on urban streets and walking. The proposed conceptual model played a critical role in advancing knowledge and in organising the way that this research was conducted. The knowledge gained by focusing on these factors has contributed to a better understanding of how to restore the pedestrians into the street space, mainly in Saudi Arabia and other countries in the Arab region. For the Kingdom, the study showed that encouraging walking on streets, for any purposes, in general, and as a lifestyle, in particular, is a real challenge. This is due to the lack of proper knowledge of the necessary tools in hands of the related designers or developers, where the street space requires to be designed on the merits of a particular context.

This is logical, as it has been reported by many researchers, for example, Hass-Klau et al. (1999); Gehl (2010); Carmona et al. (2010) and Hass-Klau (2015), that the real challenge is in balancing the elements of the consensus so as to satisfy the requirements of the targeted users. Fundamentally, it can be said that the success of any urban space relies on a clear understanding and appreciation of its local context, including the socio-cultural aspects of the anticipated users, physical and environmental conditions. However, long practices of street design, mainly through activities of the recent urban regeneration processes, which have been carried out since 2009 for major cities in the Kingdom, have revealed that the insistence; whether consciously or not, on pursuing outdated design solutions, mimicked from alien contexts, has contributed in exacerbating the pedestrians' withdrawal from the street space to other urban places.

In general, it is noted, through the review of the literature and factual materials pertinent to the Saudi context, carried out in Chapters Three and Four, respectively, that there are certain design vocabulary, qualities or considerations have been considered as important in street design. While these imperatives have been acknowledged to make a big difference towards promoting walking, in several countries in the world, mainly Europe and North America, their influential role has been neglected or underestimated in Saudi Arabia.

The cause behind this withdrawal of pedestrians from streets is largely attributed to the on-going practices of outdated street design approaches and the constant adoption of foreign solutions without proper adaptation to requirements of the local context; or it may simply be due to the lack of knowledge among practitioners of how to tackle the problem. The overall result is that there is a lack of successful context-sensitive- and context-responsive models that contribute to facilitate the restoration of walking into streets.

This research revealed the centrality of walking between the influence of socio-cultural aspects, urban microclimate conditions and street design (physical and spatial characteristics). Accordingly, in order to lead to the renaissance of urban streets in Dammam to restore walking, the street space needs to be designed in a pedestrian-friendly, climatically-responsive and socio-culturally appropriate way. Specifically, changing the physical and spatial attributes of the street space in a way compatible to the microclimatic conditions and people's socio-cultural values is required. An individual's choice to walk at different stages in the decision-making process is influenced by these variables and there is no specific factor that is more prominent in this process than others.

On one hand, the microclimatic factors and quality of the physical conditions of street space play a significant role and leave long-term effects and impressions on the individual's choice whether to walk or not. On the other hand, the socio-cultural attributes, particularly issues of privacy represented in the personal proximity, were found to act as influential mediators between characteristics of the street environment and walking.

All the information provided in this thesis fills the gap of a topic that has not been studied in-depth before. This thesis contributes also to the advance of knowledge in the urban design and landscape architecture by integrating three influential factors connected to walking in a single study; an approach which has not been elaborated previously. Ultimately, this study meets the needs of associated urban planners, designers and researchers with basic data on pedestrians' requirements and the conditions of streets in Saudi Arabia, which can be used in similar contexts.

7.6 Areas of further research

Since this research was of a highly exploratory nature, combined with the role of each data collection method employed and socio-cultural limitations, several issues and questions have emerged en route, and are still unexplored. The potential, therefore, for further research of those raised issues can be of interest for future studies to explore, either by the present researcher or by others. Such issues include:

- Given that this research is based on a subjective comfort approach through which pedestrians were selected randomly and their upper thermal comfort level was identified against the microclimatic data measured by using a handheld climate device, it would be an advance in the research area to carry out continuous microclimate measurements over a specific period in different locations of the city by utilising remote stations. Within this research area, similarly to other studies carried out in a hot-dry zone, such of that in Riyadh Saudi Arabia (Al-Ohaidib, 2002; Al-Saud, 2006; Alznafer, 2014), it would be very informative to study the impact and relationship of street geometries on air and mean radiant temperatures and humidity levels in a hot-humid region, whether in Dammam or other coastal cities in the Gulf states.

- A more reliable and accurate distance measurement between pedestrians needs to be developed in other studies. This research recommends future studies concerned with observing pedestrians, or interested in adopting the participant observation method, to use an electronic distance meter device to accurately measure the interpersonal distances between pedestrians. The reason is due to the instant or rapid measuring capability that such a device can offer without the need for direct contact with pedestrians. This is fundamental to maintain distance from pedestrians, which in turn contributes to attaining the main concept of this data collection method; i.e. to be an insider user and outsider researcher.
- The frequency of observed patterns of pedestrian behaviour, movement and activities, in addition to the most used locations within the street space; have to be observed comprehensively through other studies. The use of a video camera with time-lapse capability to record and analyse pedestrians is highly advised. For this purpose, the selection of streets needs to be carefully assessed. Vantage points within the selected streets where cameras will be mounted and their orientation to be directed also need to be carefully selected and evaluated in order to avoid attracting pedestrian’s attention or interfering with their movement.
- Detailed measurements of average walking speed of pedestrians, in Saudi Arabia and in other Arab countries, have to be defined, particularly in terms of the impact of traditional costumes on this factor, which in turn may have explanatory power to account for the pedestrians’ willingness to use streets for walking, mainly as a lifestyle. In the same context, other aspects should be also identified, because, in practice, how fast the pedestrians walk can be influenced by microclimatic conditions, age, gender, type of errands and whether the pedestrian is alone or part of a group.
- Further, among the socio-cultural aspects that need further research, by adopting a sensitive approach and carefully selected data collection methods, is to

measure the degree of acceptance, by neighbours and shopkeepers, for passers-by to sit in front of their properties.

7.7 Final message

Walking as a lifestyle can be acquired or changed, although changing the current lifestyle of the pedestrians; i.e. to move from walking in other urban places to the street space, cannot be imposed and equally, cannot be resisted; nevertheless, it is not difficult to attain. Habitual behaviour of the pedestrians to drive into other urban places instead of just walking on the streets is a form of resistance to change. This resistance is not wilfulness, but it is self-evident that the decision made by a pedestrian depends on how the available choices (street space vs. other urban spaces) are presented to him or her.

In conclusion, the absence of necessary facilitating conditions, in the form of physical and spatial design incentives or interventions, constrains lifestyle change: without a convenient pavement space that is context-sensitive, climatically-responsive and socio-culturally compatible, restoring the pedestrians into the street space will be deemed impossible. Facilitating conditions mediate the influence of intrapersonal-related factors, in terms of intention and habit, as well as gains and losses, on lifestyle change. Hence, the pedestrians would have the opportunity to accept or resist the change.

Bibliography

AASHTO (2011) *A Policy on Geometric Design of Highways and Streets*. 6th ed. Washington, D.C., USA, AASHTO.

Abdel-Ghany, A., Al-Helal, I. & Shady, M. (2013) Human Thermal Comfort and Heat Stress in an Outdoor Urban Arid Environment: A Case Study. *Advances in Meteorology*, pp. 1-9.

Abdelmonem, M. (2015) *The Architecture of Home in Cairo: Socio-Spatial Practice of the Hawari's Everyday Life*. Surrey, UK, Ashgate Publishing Ltd.

Abu-Ghazzeh, T. (1997) Vernacular architecture education in the Islamic society of Saudi Arabia: towards the development of an authentic contemporary built environment. *Habitat International*, 21 (2), pp. 229-253.

Adeyemi-Bello, T. & Kincaid, K. (2012) *The Impact of Religion and Social Structure on Leading and Organizing in Saudi Arabia*. East Carolina University. Available from: <http://www.sedsi.org/2012_Conference/proc/proc/p111014026.pdf> [Accessed 11 August 2015].

Aguiar, A., French, K. & Chisholm, L. (2014) A comparison of the ameliorating effects of native and exotic street trees on surface heat retention at dusk. *Urban Climate*, 10 (1), pp. 56-62.

Aiello, J. & Thompson, D. (1980) Personal Space, Crowding, and Spatial Behavior in a Cultural Context. In: Altman, I. et al. eds. *Human Behavior and Environment: Advances in Theory and Research*, Vol. 4, Environment and Culture. NY, USA, Plenum Press, pp. 107-178.

Aina, Y., Al-Naser, A. & Garba, S. (2013) Towards an Integrative Theory Approach to Sustainable Urban Design in Saudi Arabia: The Value of GeoDesign. In: Özyavuz, M. ed. *Advances in Landscape Architecture*. Croatia, InTech, pp.531-550.

Ajzen, I. & Fishbein, M. (1980) *Understanding attitudes and predicting social behavior*. Englewood Cliffs, N.J., USA, Prentice-Hall.

Ajzen, I. (1991) The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50 (2), pp. 179–211.

Akbar, J. (2005) *Imarat Al-Ard fi Al-Islam* (in Arabic). 4th ed. Beirut, Lebanon, Al Resalah Publishers.

Akbari, H. et al. (1992) *Cooling Our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing*. Washington, D.C., U.S. Environmental Protection Agency (EPA). Available from: <http://escholarship.org/uc/item/98z8p10x#page-30> [Accessed 30 Sept 2015].

Akbari, H., Pomerantz, M. & Taha, H. (2001) Cool Surfaces and Shade Trees to Reduce Energy Use and Improve Air Quality in Urban Areas. *Solar Energy*, 70 (3), pp. 295-310.

Al Sarhani, A. (2004) *Development of Jubail waterfront* (in Arabic). Master thesis, King Faisal University, Saudi Arabia.

Al-Abdullah, M. (1998) *Relevance of The Local People's Socio-Cultural Values in the Landscape Development of Recreational Sea Fronts of Saudi Arabia: the Case of Dammam*. PhD thesis, University of Newcastle Upon Tyne, U.K.

Al-Ajmi et al. (2008) Thermal insulation and clothing area factors of typical Arabian Gulf clothing ensembles for males and females: Measurements using thermal manikins. *Applied Ergonomics*, 39 (3), pp. 407-414.

Alangari, A. (1996) *The Revival of the Architectural Identity: The City of Arriyadh*. PhD thesis, University of Edinburgh.

Al-Awais, S. (1991) *Urban Forestry in Saudi Arabia: with special reference to street trees in the Eastern Province*. PhD thesis, University of Newcastle Upon Tyne, UK.

Aleqtisadiah (2011) *Do our streets help to encourage walking?* (in Arabic). Aleqtisadiah [Internet], 7 February. Available from: <http://www.aleqt.com/2011/02/07/article_501235.html> [Accessed 10 December 2014].

Alexander, C., Ishikawa, S. & Silverstein, M. (1977) *A Pattern Language: Towns, Buildings, Construction*. NY, Oxford University Press.

Alexander, C. et al. (1987) *A New Theory of Urban Design*. NY, Oxford University Press, Inc.

Al-Fuhaid, F. (2014) *Putting the pavements to rights would stop draining billions to treat lifestyle-related diseases* (in Arabic). Alriyadh [Internet], 07 January. Available from: <http://www.alriyadh.com/899084> [Accessed 14 June 2014].

Algeciras, J. et al. (2015) Human thermal comfort conditions and urban planning in hot-humid climates—The case of Cuba. *International journal of biometeorology*, pp. 1-14.

Al-Ghonamy, A. (2010) Analysis and Evaluation of Road Traffic Noise in Al-Dammam: A Business City of the Eastern Province of KSA. *Journal of Environmental Science and Technology*, 3 (1), pp. 47-55.

Al-Hathloul, S. & Anis-ur-Rahmaan (1985) The Evolution of Urban and Regional Planning in Saudi Arabia. *Ekistics*, 52 (312), May / June, pp. 206-212.

Al-Hathloul, S. & Mughal, M. (2004) Urban growth management-the Saudi experience. *Habitat International*, 28 (4), pp. 609-623.

Al-Hathloul, S. (1981) *Tradition, Continuity, and Change in the Physical Environment: The Arab-Muslim City*. PhD thesis, MIT, USA.

Aljawabra, F. & Nikolopoulou, M. (2010) Influence of hot arid climate on the use of outdoor urban spaces and thermal comfort: Do cultural and social backgrounds matter? *Intelligent Buildings International* [Internet], 2 (3), pp. 198-217. Available from: <https://kar.kent.ac.uk/28351/1/Aljawabra&Nikolopoulou.pdf> [Accessed 10 January 2015].

Alkahtani, H., Dawson, R. & Lock, R. (2013) The impact of culture on Saudi Arabian information systems security. In: Georgiadou, E., Ross, M. and Staples, G. eds. *Proceedings of the 21st International Conference on Software Quality Management,* *Quality Comes of Age, Southampton*, pp. 201-210. Available from: <https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/13814/3/Impact%20of%20culture-final3.pdf> [Accessed 11 August 2015].

Al-Muhaisin, S. (2014) *Streets do not encourage walking: existing pavements are located on the edge of uncomfortable roads* (in Arabic). Alriyadh [Internet], 16 January. Available from: <http://www.alriyadh.com/901349> [Accessed 24 Dec 2015].

Al-Naim, M. (2008a) Identity in Transitional Context: Open-Ended Local Architecture in Saudi Arabia. *International Journal of Architectural Research*, 2 (2), pp. 125-146.

Al-Naim, M. (2008b) Riyadh: A City of 'Institutional' Architecture. In: Elsheshtawy, Y. ed. *The Evolving Arab City: Tradition, Modernity and Urban Development*. Oxfordshire, Routledge, pp. 118-151.

Al-Said, F. (1992) *Territorial Behaviour and the Built Environment. The Case of Arab-Muslim Towns, Saudi Arabia*. PhD thesis, University of Glasgow.

Al-Saud, K. A. (2006) Heat Island Phenomena in Desert Cities: The City of Riyadh as a Case Study. *King Saud University*.

Alshaqty, H. (2012) *Localization of the automotive industry is an urgent requirement justified by annual imports of 51 Billion Riyals* (in Arabic). Al-Jazirah [Internet], 20 April. Available from: <http://www.al-jazirah.com/2012/20120420/ec3.htm> [Accessed 29 May 2014].

Al-Shuaiby, A. (1976) *The Development of the Eastern Province, with Particular Reference to Urban Settlement and Evolution in Eastern Saudi Arabia*. PhD thesis, University of Durham, UK.

Alsulami, S. (2015) *Practicing walking under the risk of run over and women go for walking under intense fear of harassment* (in Arabic). SABQ Online Newpaper, 27 February. Available from: <http://sabq.org/KDzgde> [Accessed 24 Dec 2015].

Altman, I. & Chemers, M. (1984) *Culture and Environment*. Cambridge, Cambridge University Press.

Altman, I. & Zube, E. eds. (1989) *Public Places and Spaces*. NY, Plenum Press.

Altman, I. (1975) *The environment and social behavior: privacy, personal space, territory, crowding*. Monterey, CA, USA, Cole Publishing Company.

Alznafer, B. (2014) *The Impact of Neighbourhood Geometries on Outdoor Thermal Comfort and Energy Consumption from Urban Dwellings: a Case Study of the Riyadh City, the Kingdom of Saudi Arabia*. PhD thesis, Cardiff University, UK.

Anable, J., Lane, B. & Kelay, T. (2006) *An evidence base review of public attitudes to climate change and transport*. London, UK, HMSO.

Anshel, M. (2014) *Applied Health Fitness Psychology*. Champaign, IL, USA, Human Kinetics.

Appleyard, D. (1981) *Livable Streets.* Berkeley, University of California Press.

Argaam (2013a) *Car imports to Saudi Arabia, achieve a high record in 2012* (in Arabic). Argaam [Internet], 01 August. Available from: <http://www.argaam.com/article/articledetail/355470> [Accessed 30 May 2014].

Argaam (2013b) *90 Billion Riyals for car sales annually in Saudi Arabia after 5 years* (in Arabic). Argaam [Internet], 29 December. Available from: <http://www.argaam.com/article/articledetail/387685/> [Accessed 30 May 2014].

ASHRAE (2004) *Thermal Environmental Conditions for Human Occupancy.* Atlanta, GA, USA, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

ASHRAE (2009) *Handbook - Fundamentals*. Atlanta, GA, USA, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

ASHRAE (2010) *Thermal Environmental Conditions for Human Occupancy*. Atlanta, GA, USA, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

ASHRAE (2013) *Thermal Environmental Conditions for Human Occupancy*. Atlanta, GA, USA, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Auliciems, A. & Szokolay, S. (2007) *Thermal Comfort*. 2nd ed. London: Passive and Low Energy Architecture (PLEA). Available from: <http://plea-arch.org/wp-content/uploads/PLEA-NOTE-3-THERMAL-COMFORT.pdf> [Accessed 01 January 2015].

BaHammam, O. (1995) *The Social Needs of the Users in Public Open Space: The Involvement of Socio-Cultural Aspects in Landscape Design of the Outdoor Urban Environment in Ar-Riyadh, Saudi Arabia*. PhD thesis, University of Edinburgh, UK.

BaHammam, O. (2003) Sustainable development of streetscape in the desert city of Riyadh-Saudi Arabia. *Journal of Chongqing University-Eng. Ed.*, 2, pp. 128-133. Available from: <https://www.academia.edu/2279862/Sustainable_Development_of_Street_scape_in_the_Desert_City_of_Riyadh-Saudi_Arabia> [Accessed 29 December 2014].

BaHammam, O. (2004) Analyzing Street Planting and Detecting Existing Patterns in Riyadh, Saudi Arabia. *Journal of King Saud University*, 16, pp. 1-22, Riyadh. Available from: <http://colleges.ksu.edu.sa/ArchitectureandPlanning/Documents/CAPJAbstracts/16/16_5E.pdf> [Accessed 15 January 2015].

Bahammam, O. (2006) The role of privacy in the design of the Saudi Arabian courtyard house. In: Edwards, B. at al eds. *Courtyard Housing: Past, Present and Future*. London, Taylor & Francis, pp. 102-111.

BaHammam, O. (2009) Sustainable Sidewalks and the safety of Pedestrians. *Journal of King Saud University*, pp. 1-11. Available from: <http://repository.ksu.edu.sa/jspui/bitstream/123456789/7973/1/Sustainable%20Sidewalks%20and%20the%20safety%20of%20Pedestrians.pdf> [Accessed 29 December 2014].

Bamberg, S & Schmidt, P. (2003) Incentives, Morality, or Habit? Predicting Students' Car Use for University Routes With the Models of Ajzen, Schwartz, and Triandis. *Environment & Behavior,* 35 (2), pp. 264-285.

Barrett, P. & Finch, E. (2014) *Facilities Management: The Dynamics of Excellence*. 3rd ed. West Sussex, UK, John Wiley & Sons, Ltd.

Bauman, A. et al. (2002) Toward a Better Understanding of the Influences on Physical Activity: The Role of Determinants, Correlates, Causal Variables, Mediators, Moderators, and Confounders. *American Journal of Preventive Medicine*, 23 (2), pp. 5-14.

Bechtel, R. & Zeisel, J. (1987) Observation: the World under a Glass. In: Bechtel et al. eds. *Methods in environmental and behavioral research*. NY, Van Nostrand, pp. 11-40.

Bechtel, R. (1987) The Ubiquitous World of Paper and Pencil Tests. In: Bechtel et al. eds. *Methods in environmental and behavioral research*. NY, Van Nostrand, pp. 82-119.

Beer, A. & Higgins, C. (2005) *Environmental Planning for Site Development: A manual for sustainable local planning and design*. 2nd ed. London, UK, E & FN Spon.

Bell, S. (2013) Sustainable Landscapes. In: Loftness, V. & Haase, D. eds. *Sustainable Built Environments*. NY, USA, Springer, pp. 671-700.

Bergström, F. (2004) *How People's Concepts of Urban Places Relate to Their Evaluations of the Places' Aesthetics and Microclimate*. Master Thesis, University of Linköping, Sweden.

Bernard, H. (2006) *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. 4th ed. Oxford, UK, AltaMira Press.

Bianca, S. (2000) *Urban form in the Arab world, past and present*. NY, USA, Thames and Hudson.

Bin Marshad, S. M. (2014) *Economic Evaluation of Seawater Desalination: A Case Study Analysis of Cost of Water Production from Seawater Desalination in Saudi Arabia*. PhD thesis, Heriot Watt University.

Bjelica, D. et al. (2012) Body height and its estimation utilising arm span measurements in Montenegrin adults. *Anthropological Notebooks* [Internet], 18 (2), pp. 69 - 83. Available from: <http://www.drustvo-antropologov.si/AN/PDF/2012_2/Anthropological_Notebooks_XVIII_2_Bjelica.pdf> [Accessed 30 September 2014].

Blomley, N. (2011) *Rights of Passage: Sidewalks and the regulation of public flow*. London, UK, Routledge.

Bosselmann, P. et al. (1995) Urban Form and Climate: Case Study, Toronto. *Journal of the American Planning Association*, 61 (2), pp. 226-239.

Boussoualim, A. (2000) Towards a method of characterisation of the link between climate, urban morphology and user's behaviour in external public space. In: *Architecture, City, Environment, Proceedings of PLEA 2000*. July, 2000, Cambridge, UK, James & James (Science Publishers) Ltd., pp. 459-464.

Brager, G. & de Dear, R. (2003) Historical and cultural influences on comfort expectations. In: Cole, R. & Lorch, R. eds. *Buildings, Culture and Environment: Informing local and global practices*. Oxford, UK, Blackwell Publishing Ltd, pp. 177-201.

Brewer, J (2000) *Ethnography*. Buckingham, UK, Open University Press.

Brinkmann, S. & Kvale, S. (2015) *InterViews: Learning the Craft of Qualitative Research Interviewing*. 3rd ed. London, UK, Sage Publications Ltd.

Bryman, A. (2016) *Social Research Methods*. 5th ed. Oxford, UK, Oxford University Press.

Burgess, R. (2006) *In the Field: An Introduction to Field Research*. Taylor & Francis e-Library.

Calthorpe, P. (1993) *The Next American Metropolis: Ecology, Community, and the American Dream.* NY, Princeton Architectural Press.

Campbell, K. & Cowan, R. (2002) *Re:urbanism*. London, UK, Urban Exchange.

Cândido, C. et al. (2010) Air movement acceptability limits and thermal comfort in Brazil's hot humid climate zone. *Building and Environment*, 45 (1), pp. 222-229.

Canter, D. (1974) *Psychology for Architects*. London, UK, Applied Science Publishers.

Canter, D. (1977) *The Psychology of Place*. London, UK, Architectural Press.

Canter, D. (1996) In Search of Objectives: An Intellectual Autobiography. In: *Psychology in Action*. Hantshire, UK, Dartmouth Publishing Company, pp. 3-22. Available from: <http://eprints.hud.ac.uk/9221/1/CANTER_3.pdf > [Accessed 25 Sept 2015].

Carmona, M. et al. (2010) *Public Places – Urban Spaces: The Dimensions of Urban Design*. 2nd ed. Oxford, UK, Architectural Press.

Carr, S. et al. (1992) *Public Space*. Cambridge, UK, Cambridge University Press.

Cheng, V. & Ng, E. (2008) Outdoor Thermal Comfort for Hong Kong People: Transverse Survey and Longitudinal Study. In: Katzschner, L. ed. *Proceedings of the Workshop: Thermal Comfort in Urban Planning and Architecture under Consideration of Global Climate Change, February 20-21, 2008, Kassel, Germany*. Department of Environmental Meteorology, pp. 222-244. Available from: <https://kobra.bibliothek.uni-kassel.de/bitstream/urn:nbn:de:hebis:34-2008042121208/1/booklet_workshop_kassel_08.pdf> [Accessed 04 January 2015].

Clay, G. (1987) *Right Before Your Eyes: Penetrating the Urban Environment*. Washington, DC, Planners Press, American Planning Association.

Coutts, A. et al. (2015) Temperature and human thermal comfort effects of street trees across three contrasting street canyon environments. *Theoretical and Applied Climatology*, pp. 1-14.

Crane, R. (2000) The Influence of urban form on travel: An interpretive review. *Journal of Planning Literature*, 15 (1), pp. 3-23.

Crawford, J. (2002) *Carfree Cities*. Utrecht, Netherlands, International Books.

Creswell, J. (2014) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 4th ed. London, UK, Sage Publications, Inc.

Creswell, J. (2015) *A Concise Introduction to Mixed Methods Research*. London, UK, Sage Publications, Inc.

Cullen, G. (1961) *The Concise Townscape*. London, UK, Architectural Press.

da Silva, F & de Alvarez, C. (2015) An integrated approach for ventilation's assessment on outdoor thermal comfort. *Building and Environment*, 87, pp. 59-71.

Dadfar, A. et al. (2003) *Intercultural Aspects of Doing Business with Saudi Arabia*. Linkoping, Sweden, Linkoping University. Available from: <http://www.iei.liu.se/indek/utbildning/industriell-marknadsforing/teim03/file-archive-2012/1.416547/ExampleofProjectwork-DoingbusinesswithSaudiArabaia.pdf> [Accessed 23 Sept 2015].

Dammam Municipality (1997) *Metropolitan Dammam*. London, UK, North Star Publishing.

Darnton, A. (2008a) *Practical Guide: An overview of behaviour change models and their uses* [Internet]. Government Social Research. Available from: <www.gsr.gov.uk> [Accessed 3 February 2011].

Darnton, A. (2008b) *Behaviour Change Knowledge Review – Reference Report: An overview of behaviour change models and their uses* [Internet]. Available from: <www.gsr.gov.uk> [Accessed 3 February 2011].

Dawoud, M., Shabraq, S. & Al Saghir, M. (2011) *Saudi women more obese than men* (in Arabic). Okaz [Internet], 18 May. Available from: <http://www.okaz.com.sa/new/Issues/20110518/PrinCon20110518420319.htm> [Accessed 28 May 2014].

de Montigny, L., Ling, R. & Zacharias, J. (2012) The effects of weather on walking rates in nine cities. *Environment and Behavior*, 44 (6), pp. 821-840.

Deb, C. & Ramachandraiah, A. (2010) The significance of Physiological Equivalent Temperature (PET) in outdoor thermal comfort studies. *International Journal of Engineering Science and Technology,* 2 (7), pp. 2825-2828.

Dennis, K. & Urry, J. (2009) *After the Car*. Cambridge, UK, Polity Press.

Department for Transport 'DfT' (2007) *Manual for Streets*. London, UK, Thomas Telford Publishing. Available from: <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3891/pdfmanforstreets.pdf> [Accessed 07 June 2014].

DeWalt, K. & DeWalt, B. (2011) *Participant Observation: A Guide for Fieldworkers*. 2nd ed. Plymouth, UK, AltaMira Press.

Dover, V. & Massengale, J. (2014) *Street Design: The Secret to Great Cities and Towns*. NJ, USA, John Wiley & Sons.

Downs, R. & Stea, D. (1973) Cognitive Maps and Spatial Behavior: Process and Products. In: Downs, R. & Stea, D. eds. *Image and Environment: Cognitive Mapping and Spatial Behavior*. London, UK, Transaction Publishers, pp. 8-26.

Edwards, B. (2013) *Drawing on the Right Side of the Brain: A Course in Enhancing Creativity and Artistic Confidence*. 4th ed. London, UK, Souvenir Press.

Eliasson, I & Thorsson, S. (2008) Urban Climate Spaces. In: Katzschner, L. ed. *Proceedings of the Workshop: Thermal Comfort in Urban Planning and Architecture under Consideration of Global Climate Change, February 20-21, 2008, Kassel, Germany*. Department of Environmental Meteorology, pp. 72-110. Available from: <https://kobra.bibliothek.uni-kassel.de/bitstream/urn:nbn:de:hebis:34-2008042121208/1/booklet_workshop_kassel_08.pdf> [Accessed 4 January 2015].

Elsheshtawy, Y. ed. (2008) *The Evolving Arab City: Tradition, Modernity and Urban Development*. London, UK, Routledge.

Erell, E., Pearlmutter, D. & Williamson, T. (2011a) *Urban Microclimate: Designing the Spaces Between Buildings*. Oxon, UK, Earthscan.

Erell, E., Pearlmutter, D. & Williamson, T. (2011b) Urban Microclimate – Designing the Spaces between Buildings. In: Hebbert, M. et al. eds. *Proceedings of City weathers: meteorology and urban design 1950-2010, June 23-24, 2011, Manchester, UK*. Manchester Architecture Research Centre. pp. 127-131. Available from: <http://orca.cf.ac.uk/65932/> [Accessed 29 August 2015].

Ewing, R. (1999) *Pedestrian- and transit-friendly design: a primer for Smart growth*. Washington, DC, USA, Smart Growth Network. Available from: <http://www.epa.gov/smartgrowth/pdf/ptfd_primer.pdf> [Accessed 07 June 2014].

Ewing, R., & Cervero, R. (2001) Travel and the built environment: A synthesis. *Transportation Research Record: Journal of the Transportation Research Board*, 1780, pp. 87-112.

Ewing, R. (2002) Impediments to context-sensitive main street design. *Transportation Quarterly*, 56 (4), pp. 51-64.

Ewing, R. (2005). Can the physical environment determine physical activity levels? *Exercise and Sport Sciences Reviews*, 33 (2), pp. 69-75.

Fadan, Y. (1983) *The Development of Contemporary Housing in Saudi Arabia (1950–1983): a study in cross-cultural influence under conditions of rapid change*. PhD thesis, MIT, USA.

Fanger, P. (1970) *Thermal Comfort*. Copenhagen, Danish Technical Press.

Fanger, P., Breum, N. & Jerking, E. (1977) Can colour and noise influence man's thermal comfort?. *Ergonomics*, 20 (1), pp. 11-18.

Fintikakis, N. et al. (2011) Bioclimatic Design of Open Public Spaces in the Historic Centre of Tirana, Albania. *Journal of Sustainable Cities and Society*, 1 (1), pp. 54-62.

Fishbein, M. & Ajzen, I. (1975) *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading, MA, USA, Addison-Wesley. Available from: <http://people.umass.edu/aizen/f&a1975.html> [Accessed 22 June 2014].

Fisher, S. (2014) *Development and Structure of the Body Image*. NY, USA, Psychology Press, pp. 371-372.

Foddy, W. (2001) *Constructing Questions for Interviews and Questionnaires: Theory and Practice in Social Research*. Cambridge, UK, Cambridge University Press.

Foltête, J. & Piombini, A. (2007) Urban layout, landscape features and pedestrian usage. *Landscape and Urban Planning*, 81 (3), pp. 225-234.

Francis, M (1991) The Making of Democratic Streets. In Moudon, A.V. ed. *Public Streets for Public Use*. NY, USA, Columbia University Press, pp. 23-39.

Fraser, P. (2012) Approaches to the Public Realm. *Urban Design Group Journal*, 124, Urban Design in the Middle East, pp. 26-27.

Gaitani, N., Mihalakakou, G. & Santamouris, M. (2007) On the use of bioclimatic architecture principles in order to improve thermal comfort conditions in outdoor spaces. *Building and Environment*, 42 (1), pp. 317-324.

Gehl, J & Gemzøe, L. (1996) *Public Spaces - Public Life*. Copenhagen, Danish Architectural Press.

Gehl, J. & Hook, W. (2010) *Our Cities Ourselves: 10 Principles for Transport in Urban Life*. Institute for Transportation & Development Policy. Available from: <http://www.itdp.org/documents/2010-OurCitiesOurselves_Booklet.pdf> [accessed 17 March 2011].

Gehl, J. (2010) *Cities for People*. Washington, DC, USA, Island Press.

Gehl, J. (2011) *Life Between Buildings: Using Public Spaces*. 6th ed. Washington, DC, USA, Island Press.

Gehl, J. and Svarre, B. (2013) *How to Study Public Life*. London, UK, Island Press.

Ghasemi, Z., Esfahani, M. & Bisadi, M. (2015) Promotion of Urban Environment by Consideration of Human Thermal & Wind Comfort: A Literature Review. *Procedia-Social and Behavioral Sciences*, 201, pp. 397-408.

Ghodsi, H. (2013) *Vernacular Architecture: Solution to a more sustainable future*. Master thesis, Robert Gordon University, UK.

Gibbons, J. & Oberholzer, B. (1991) *Urban Streetscapes: A Workbook for Designers*. Oxford, BSP Professional Books.

Giddens, A. (2002) *Sociology*. 4th ed. Cambridge, Polity publishing.

Gifford, R. (2007) *Environmental Psychology: Principles and Practice*. 4th ed. Colville, WA, Optimal Books.

Gifford, R., Steg, L. & Reser, J. (2011) Environmental Psychology. In: Martin et al. eds. *The IAAP Handbook of Applied Psychology*. West Sussex, UK, Blackwell Publishing Ltd., pp. 440-470.

Glanz, K. & Rimer, B. (2005) *Theory at a Glance: A Guide for Health Promotion Practice*. [Internet]. National Cancer Institute, U.S. Department of Health and Human Services and National Institutes of Health. Available from: <http://www.cancer.gov/cancertopics/cancerlibrary/theory.pdf> [accessed: 10 March 2011].

Golicnik, B. (2005) *People in Place: a Configuration of Physical Form and the Dynamic Patterns of Spatial Occupancy in Urban Open Public Space*. PhD thesis, Heriot-Watt University.

Gonçalves, A., Ribeiro, A. & Feliciano, M. (2008) Thermal Comfort Studies in Green Spaces, Bragança, Portugal. In: Katzschner, L. ed. *Proceedings of the Workshop: Thermal Comfort in Urban Planning and Architecture under Consideration of Global Climate Change, February 20-21, 2008, Kassel, Germany*. Department of Environmental Meteorology, pp. 245-265. Available from: <https://kobra.bibliothek.uni-kassel.de/bitstream/urn:nbn:de:hebis:34-2008042121208/1/booklet_workshop_kassel_08.pdf> [Accessed 04 January 2015].

Guest, G., Namey, E. & Mitchell, M. (2013) *Collecting Qualitative Data: A Field Manual for Applied Research*. London, UK, Sage Publications, Inc.

Hakim, B. (1989) Islamic Architecture and Urbanism. In: Wilkes, J. and Packard, R. ed. *Encyclopedia of Architecture: Design, Engineering and Construction*, 3, NY, USA, John Wiley & Sons, Inc., pp.86-103.

Hall, E. (1966) *The Hidden Dimension*. NY, USA, Anchor Books.

Hall, E. (1974) *Handbook for proxemic research*. Washington, USA, Society for the Anthropology of Visual Communication.

Hall, E. (1989) *Beyond Culture*. NY, USA, Anchor Books.

Handy, S. (2004) *Critical Assessment of the Literature on the Relationships Among Transportation, Land Use, and Physical Activity*. TRB Special Report 282. University of California, Davis, the Committee on Physical Activity, Health, Transportation, and Land Use. Available from: <http://onlinepubs.trb.org/onlinepubs/archive/downloads/sr282papers/sr282Handy.pdf> [Accessed 8 March 2011].

Handy, S. (2005) *Does the Built Environment Influence Physical Activity? Examining the Evidence*. TRB Special Report 282. Washington, D.C., Transportation Research Board. Available from: <http://onlinepubs.trb.org/onlinepubs/sr/sr282.pdf> [Accessed 8 March 2011].

Handy, S. et al. (2002) How the built environment affects physical activity: Views from urban planning. *American Journal of Preventive Medicine*, 23 (2), pp. 64-73.

Handy, S., Cao, X. & Mokhtarian, P. L. (2006) Self-Selection in the Relationship between the Built Environment and Walking: Empirical Evidence from Northern California. *Journal of the American Planning Association*, 72 (1), pp. 55-74.

Hass-Klau, C. (1990) *The Pedestrian and City Traffic*. London, UK, Belhaven Press.

Hass-Klau, C. et al. (1999) *Streets as Living Space*. London, UK, Landor Publishing Ltd.

Hass-Klau, C. (2015) *The Pedestrian and the City*. London, UK, Routledge.

Hazel, George (2003) Urban Streets. *The Journal of the Urban Design Group*, Winter, 85, pp. 20-21.

Hebbert, M. & Jankovic, V. (2011) City Weathers. In: Hebbert, M., Jankovic, V. & Webb, B. eds. *Proceedings of City weathers: meteorology and urban design 1950-2010, June 23-24, 2011, Manchester, UK*. Manchester Architecture Research Centre. pp. 9-14. Available from: <http://orca.cf.ac.uk/65932/> [Accessed 29 August 2015].

Hebbert, M., Jankovic, V. & Webb, B. eds. (2011) *Proceedings of City weathers: meteorology and urban design 1950-2010, June 23-24, 2011, Manchester, UK*. Manchester Architecture Research Centre. Available from: <http://orca.cf.ac.uk/65932/> [Accessed 29 August 2015].

Heft, H. & Nasar, J. (2000) Evaluating Environmental Scenes Using Dynamic Versus Static Displays. *Environment and Behavior*, 32 (3), pp. 301-322.

Hensel, H. (1981) *Thermoreception and Temperature Regulation*. London, UK, Academic Press.

High Commission for the Development of Arriyadh (2012) *87% are demanding to increase places for walking in the capital* (in Arabic). ArRiyadh [Internet], 15 January. Available from: <http://www.arriyadh.com/ar/ADA/Content/getdocument.aspx?f=/openshare/ar/ADA/Content/231.doc_cvt.htm> [Accessed 26 June 2014].

Hiron, B., Isler, A. & Tortel, F. (2014) *Signs and signals for cyclists and pedestrians: Comparison of rules and practices in 13 countries* [Online]. World Health Organization (WHO), Regional Office for Europe. Available from: <http://www.developpement-durable.gouv.fr/IMG/pdf/Signs_and_signals_EN_2_.pdf> [Accessed: 20 May 2014].

Höppe, P. (1992) A new procedure to determine the mean radiant temperature outdoors. *Wetter und Leben*, 44, pp. 147-151.

Höppe, P. (1999) The physiological equivalent temperature - a universal index for the biometeorological assessment of the thermal environment. *International Journal of Biometeorology*, 43 (2), pp. 71-75.

Höppe, P. (2002) Different aspects of assessing indoor and outdoor thermal comfort. *Energy and Buildings*, 34 (6), pp. 661-665.

Höppe, P. and Seidl, H. (1991) Problems in the assessment of the bioclimate for vacationists at the seaside. *International Journal of Biometeorology*, 35 (2), pp. 107-110.

Hoyle, R., Harris, M. & Judd, C. (2002) *Research Methods in Social Relations*. 7th ed. Fort Worth, TX, USA, Wadsworth Publishing Co. Inc.

Hsia, HC. et al. (2010) Comparison of Walking Image among Different Age Groups in Taiwanese Cities. *Journal of the Eastern Asia Society for Transportation Studies* [Internet], 8, pp. 1245-1260. Available from: <https://www.jstage.jst.go.jp/article/easts/8/0/8_0_1245/_pdf> [Accessed 11 August 2014].

Hume, L. & Mulcock, J. eds. (2004) *Anthropologists in the Field: Cases in Participant Observation*. Chichester, UK, Columbia University Press.

Hwang, R., Lin, T. & Matzarakis, A. (2011) Seasonal effects of urban street shading on long-term outdoor thermal comfort. *Building and Environment*, 46 (4), pp. 863-870.

Iowa Environmental Mesonet (IEM), Iowa State University of Science and Technology. Available from: <http://mesonet.agron.iastate.edu/sites/windrose.phtml?station=OEDF&network=SA__ASOS> [Accessed 6 Sept 2016].

Institute of Transportation Engineers (2010) *Design Walkable Urban Thoroughfares: A Context Sensitive Approach*. Available from: <http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad> [Accessed 23 Sept 2015].

ISB (2009) *Universal Thermal Climate Index UTCI* [Online]. Available from: <www.utci.org> [Accessed 13 January 2015].

Jaber, S. (2013) *Urban Streets: Towards Sustainable Mobility in Arabic Cities*. PhD thesis, University of Stuttgart. Available from: <http://elib.uni-stuttgart.de/opus/volltexte/2013/8533/pdf/Book.pdf> [Accessed 27 August 2015].

Jackson, T. (2005). *Motivating Sustainable Consumption: A review of evidence on consumer behaviour and behavioural change.* A report to the Sustainable Development Research Network. Surrey, UK, University of Surrey.

Jacobs, A. (1995) *Great Streets.* Cambridge, The MIT Press.

Jacobs, J. (1961) *The Death and Life of Great American Cities.* NY, USA, Random House.

Jacobs, J. (2004) *Dark Age Ahead*. NY, USA, Random House.

Johansson, E. & Emmanuel, R. (2006) The influence of urban design on outdoor thermal comfort in the hot, humid city of Colombo, Sri Lanka. *International Journal of Biometeorology*, 51 (2), pp. 119-133.

Johansson, E. et al (2014) Instruments and methods in outdoor thermal comfort studies - The need for standardization. *Urban Climate*, 10 (2), pp. 346-366.

Karatasou, S., Laskari, M. & Santamouris, M. (2014) Models of behavior change and residential energy use: a review of research directions and findings for behavior-based energy efficiency. *Advances in Building Energy Research*, 8 (2), pp. 137-147.

Kelly, K. & Schnadelbach, R. (1976) *Landscaping the Saudi Arabian Desert*. Philadelphia, USA, The Delancey Press.

Kent, F., (2005) *Streets are People Places*. Project for Public Spaces [Internet], 1 June. Available from: <http://www.pps.org/blog/transportationasplace/> [Accessed 27 June 2014].

Khushaim, M. (2013) *Percentage of obesity in the Saudi society reaches 35%* (in Arabic). Al Arabiya.net, [Internet], 6 June. Available from: <http://www.alarabiya.net/ar/saudi-today/2013/06/06/%D9%86%D8%B3%D8%A8%D8%A9-%D8%B2%D9%8A%D8%A7%D8%AF%D8%A9-%D8%A7%D9%84%D9%88%D8%B2%D9%86-%D9%81%D9%8A-%D8%A7%D9%84%D9%85%D8%AC%D8%AA%D9%85%D8%B9-%D8%A7%D9%84%D8%B3%D8%B9%D9%88%D8%AF%D9%8A-%D8%AA%D8%B5%D9%84-%D8%A5%D9%84%D9%89-35-.html> [Accessed 20 September 2013].

Kitchenham, A. (2010) Mixed Methods in Case Study Research. In: Mills, A., Durepos, G. & Wiebe, E. eds. *Encyclopedia of case study research*, 2. London, UK, Sage Publications, Inc., pp. 561-563.

Koelbl, S. (2013) *Mobility for Women: Riyadh Metro Promises Social Change*. Spiegel Online [Internet], 09 August. Available from: <http://www.spiegel.de/international/world/new-riyadh-metro-could-usher-in-social-change-in-saudi-arabia-a-915531.html> [Accessed 27 February 2014].

Konarska, J. et al. (2014) Transmissivity of solar radiation through crowns of single urban trees—application for outdoor thermal comfort modelling. *Theoretical and applied climatology*, 117 (3-4), pp. 363-376.

Konarska, J. et al. (2015) Transpiration of urban trees and its cooling effect in a high latitude city. *International journal of biometeorology*, pp. 1-14.

Kostof, S. (1992) *The City Assembled*. London, UK, Thames and Hudson Ltd.

Kott, J. (2011) *Streets of Clay: Design and Assessment of Sustainable Urban and Suburban Streets*. PhD thesis, Curtin University, Australia.

Kremelberg, D. (2011) *Practical Statistics: A Quick and Easy Guide to SPSS, STATA and Other Statistical Software*. London, Sage Publications Ltd.

Kurose, S., Deguchi, A. & Zhao, S. (2009) Comparative Study of Pedestrian Behavior in Central Shopping Areas of East Asian Cities. In: Timmermans, H. ed. *Pedestrian Behavior: Models, Data Collection and Applications*. Bingley, UK, Emerald Group Publishing Limited, pp. 267-282.

LaGro, J. (2008) *Site Analysis: A Contextual Approach to Sustainable Land Planning and Site Design*. 2nd ed. NJ, USA, John Wiley & Sons, Inc.

Lang, J. (1987) *Creating Architectural Theory: The Role of The Behavioral Sciences in Environmental Design*. NY, USA, Van Nostrand Reinhold Company Inc.

Lang, J. (1994) Functionalism. In: Carmona, M. & Tiesdell, S. eds. (2007). *Urban Design Reader*. Oxford, UK, Architectural Press, pp. 213-225.

Laplante, J. (2007) Retrofitting urban arterials into complete streets. *Proceedings of the 3rd Urban Street Symposium: Uptown, Downtown, or Small Town – Designing Streets that Work*. Seattle, WA, Transportation Research Board. Available from: <http://www.urbanstreet.info/3rd_symp_proceedings/Retrofitting%20Urban%20Arterials%20into%20Complete%20Streets.pdf> [Accessed 07 June 2014].

Laplante, J., & McCann, B. (2008) Complete streets: We can get there from here. *ITE Journal*, 78 (5), pp. 24-28.

Leech, J. et al. (2000) Outdoor air pollution epidemiologic studies. *American Journal of Respiration and Critical Care Medicine*, 161 (3), A308.

Lenzholzer, S. (2008) Thermal comfort experience in urban public space: case-studies on Dutch urban squares. In: Katzschner, L. ed. *Proceedings of the Workshop: Thermal Comfort in Urban Planning and Architecture under Consideration of Global Climate Change, February 20-21, 2008, Kassel, Germany*. Department of Environmental Meteorology, pp. 174-221. Available from: <https://kobra.bibliothek.uni-kassel.de/bitstream/urn:nbn:de:hebis:34-2008042121208/1/booklet_workshop_kassel_08.pdf> [Accessed 04 January 2015].

Levinson, R. et al. (2007) Methods of Creating Solar-Reflective NonWhite Surfaces and Their Application to Residential Roofing Materials. *Journal of Solar Energy Materials and Solar Cells*, 91 (4), pp. 304-314.

Lin, C., Lin, T. & Hwang, R. (2013) Thermal Comfort for Urban Parks in Subtropics: Understanding Visitor's Perceptions, Behavior and Attendance. In: Nastos, P. et al. eds. *Advances in Urban Biometeorology*. Hindawi Publishing Corporation, pp. 83-90.

Lin, T. & Matzarakis, A. (2007) Bioclimate and tourism potential in National Parks of Taiwan. In: Matzarakis A. et al. eds. *Developments in Tourism Climatology*. pp. 59-65.

Lin, T. & Matzarakis, A. (2008) Tourism climate and thermal comfort in Sun Moon Lake, Taiwan. *International Journal of Biometeorology*, 52 (4), pp. 281-290.

Lin, T. (2009) Thermal perception, adaptation and attendance in a public square in hot and humid regions. *Building and Environment*, 44 (10), pp. 2017-2026.

Lin, T. et al. (2008) The comparison of thermal sensation and acceptable range for outdoor occupants between Mediterranean and subtropical climates. *Proceedings 18th International Congress of Biometeorology (ICB 2008), International Society of Biometeorology*, Tokyo, Japan, 22-26 September 2008.

Lin, T. et al. (2013) Effects of thermal comfort and adaptation on park attendance regarding different shading levels and activity types. *Building and Environment*, 59, pp. 599-611.

Lin, T. et al. (2014) Outdoor thermal perception in different climatic regions. Initial results from Taichung (Taiwan) and Lisbon (Portugal). *Finisterra*, 49 (98), pp. 49-58.

Lin, T., Ho, Y. & Huang, Y. (2007) Seasonal Effect of Pavement on Outdoor Thermal Environments in Subtropical Taiwan. *Building and Environment*, 42 (12), pp. 4124-4131.

Lin, T., Matzarakis, A. & Hwang, R. (2010) Shading effect on long-term outdoor thermal comfort. *Building and Environment*, 45 (1), pp. 213-221.

Lipton, B. (2015) *The Biology of Belief: Unleashing the Power of Consciousness, Matter & Miracles*. NY, USA, Hay House, Inc.

Litman, T. (2014) *Evaluating Complete Streets: The Value of Designing Roads for Diverse Modes, Users and Activities*. Victoria Transport Policy Institute. Available from:<http://www.vtpi.org/compstr.pdf> [Accessed: 30 May 2014].

Lynch, K. (1960) *The Image of the City*. Cambridge, MA, USA, MIT Press.

Lynch, K. (1965) The City as Environment. In: Banerjee, T. & Southworth, M. eds. (1995) *City Sense and City Design: Writings and Projects of Kevin Lynch*. Cambridge, MA, The MIT Press, pp. 87-95.

Lynch, K. (1984) Good City Form. Cambridge, MA, USA, MIT Press.

Maco, S. & McPherson, E. (2002) Assessing canopy cover over streets and sidewalks in street tree populations. *Journal of Arboriculture*, 28 (6), pp. 270-276.

Madden, S. (1999) Proxemics and gender: Where's the spatial gap? *North Dakota Journal of Speech & Theatre*, 12, pp. 41-46.

Magold, M. et al. (2014) *From Amsterdam to Paris and beyond: the Transport, Health and Environment Pan-European Programme (THE PEP) 2009–2020* [Online]. World Health Organization, Regional Office for Europe. Available from: <http://www.euro.who.int/__data/assets/pdf_file/0009/247185/From-Amsterdam-to-Paris-and-beyond-Eng.pdf> [Accessed 20 May 2014].

Maio, G. et al. (2007) Social Psychological Factors in Lifestyle Change and Their Relevance to Policy. *Social Issues and Policy Review*, 1 (1), pp. 99-137.

Marcus, C. & Francis, C. eds. (1998) *People Places: Design Guidelines for Urban Open Space*. 2nd ed. Toronto, Canada, John Wiley & Sons, Inc.

Marshall, S. (2005) *Streets & Patterns*. London, UK, Spon Press.

Masdar City (2010) *Exploring the Masdar Institute Campus*. Available from: <http://masdarcity.thampydigital.com/userfiles/files/brochures/exploring_masdar_institute.pdf> [Accessed 21 December 2015].

Mateo-Babiano, I. & Ieda, H. (2007) Street Space Sustainability in Asia: The Role of the Asian Pedestrian and Street Culture. *Journal of the Eastern Asia Society for Transportation Studies*, 7, pp. 1915-1930.

Matzarakis, A. & Mayer, H. (1996) Another kind of environmental stress: thermal stress. *WHO News*. pp. 7-10.

Matzarakis, A., Mayer, H. & Iziomon, M. (1999) Applications of a universal thermal index: physiological equivalent temperature. *International Journal of Biometeorology*, 43 (2), pp. 76-84.

Matzarakis, A., Rutz, F. & Mayer, H. (2007) Modelling radiation fluxes in simple and complex environments – application of the RayMan model. *International Journal of Biometeorology*, 51 (4), pp. 323-334.

Matzarakis, A., Rutz, F. & Mayer, H. (2010) Modelling radiation fluxes in simple and complex environments – basics of the RayMan model. *International Journal of Biometeorology*, 54 (2), pp. 131-139.

Mayer, H. & Höppe, P. (1987) Thermal Comfort of Man in Different Urban Environments. *Theoretical and Applied Climatology*, 38 (1), pp. 43-49.

Mayer, H. et al. (2009) Human thermal comfort below the canopy of street trees on a typical Central European summer day. *Ber. Meteor. Inst*. Univ. Freiburg, 18, pp. 211-219. Available from: <http://www.urbanclimate.net/matzarakis/papers/BMIUF_18_2009_Kuppeetal.pdf> [Accessed August 2015].

McCann, B. (2013) *Completing Our Streets: The Transition to Safe and Inclusive Transportation Networks*. Washington, DC, USA, Island Press.

McCullough, E., Jones, B. & Huck, J. (1984) *A Comprehensive Data Base for Estimating Clothing Insulation*. Manhattan, Kansas State University. Available from: <http://www.cbe.berkeley.edu/research/other-papers/McCullough%20et%20al%201985%20A%20comprehensive%20data%20base%20for%20estimating%20clothing%20insulation.pdf> [Accessed 4 December 2014].

Merriam, S. (1998) *Qualitative Research and Case Study Applications in Education*. San Francisco, CA, USA, Jossey-Bass.

Merriam, S. (2002) *Qualitative Research in Practice: Examples for Discussion and Analysis*. San Francisco, CA, USA, Jossey-Bass.

Miles, M., Huberman, A. & Saldaña, J. (2014) *Qualitative Data Analysis: A Methods Sourcebook*. 3rd ed. London, UK, SAGE Publications, Ltd.

Mligo, E.(2013) *Doing Effective Fieldwork: A Textbook for Students of Qualitative Field Research in Higher-Learning Institutions*. Eugene, Oregon, USA, Resource Publications.

Molnar, D. (2015) *Anatomy of a Park: Essentials of Recreation Area Planning and Design.* 4th ed. Long Grove, IL, USA, Waveland Press, Inc.

MOMRA (2006) *Design Manual for Pavements and Islands in Streets* (in Arabic). Riyadh, KSA, Ministry of Municipal and Rural Affairs.

Moore, G. (2004) Environment, behaviour and society: A brief look at the field and some current EBS research at the University of Sydney. In: *The 6th International Conference of the Environment-Behavior Research Association Tianjin, China*. Available from:

<http://sydney.edu.au/architecture/documents/staff/garymoore/114.pdf> [Accessed 19 October 2015].

Moore, R. & Cosco, N. (2010) Using behaviour mapping to investigate healthy outdoor environments for children and families: conceptual framework, procedures and applications. In: Ward Thompson et al. eds. *Innovative Approaches to Researching Landscape and Health – Open Space: People Space 2*. London, UK, Routledge, pp. 33-73.

Moudon, A. ed. (1991) *Public Streets for Public Use*. NY, USA, Colombia University Press.

Moudon, A. (1997) Urban morphology as an emerging interdisciplinary field. *Urban morphology*, 1, pp. 3-10.

Moudon, A. & Lee, C. (2003) Walking and bicycling: An evaluation of environmental audit instruments. *American Journal of Health Promotion*, 18 (1), pp. 21-37.

Moustris, K., Nastos, P. & Paliatsos, A. (2013) One-Day Prediction of Biometeorological Conditions in a Mediterranean Urban Environment Using Artificial Neural Networks Modeling. In: Nastos, P. et al. eds. *Advances in Urban Biometeorology*. Hindawi Publishing Corporation, pp. 31-45.

Murakami, S. et al. (1999) CFD analysis of wind climate from human scale to urban scale. *Journal of Wind Engineering and Industrial Aerodynamics*, 81 (1), pp. 57-81.

Nag, P. (1986) Environmental Perception. In: Singh, H. ed. *Geography and Environment: Issues and Challenges*. New Delhi, India, Concept Publishing Company, pp. 31-50.

Nagara, K., Shimoda, Y. & Mizuno, M. (1996) Evaluation of the thermal environment in an outdoor pedestrian space. *Atmospheric Environment*, 30 (3), pp. 497-505.

Namazian, P. & Mehdipour, A. (2013) Psychological Demands of the Built Environment, Privacy, Personal Space and Territory in Architecture. *International Journal of Psychology and Behavioral Sciences*, 3 (4), pp. 109-113.

Nasar, J. (1998) *The Evaluative Image of the City*. Thousand Oaks, CA, SAGE Publications.

National Association of City Transportation Officials 'NACTO' (2013) *Urban Street Design Guide*. NY, USA, Island Press.

Neuman, W. (2014) *Social Research Methods: Qualitative and Quantitative Approaches*. 7th ed. Essex, UK, Pearson Education Limited.

Newman, P. & Kenworthy, J. (1999) *Sustainability and Cities: Overcoming Automobile Dependence.* Washington DC, USA, Island Press.

Newman, P. & Kenworthy, J. (2000) The Ten Myths of Automobile Dependence. *World Transport Policy & Practice*, 6 (1), pp.15-25.

Newman, P. & Kenworthy, J. (2015) *The End of Automobile Dependence: How Cities are Moving Beyond Car-Based Planning*. Washington, DC, USA, Island Press.

Ng, E. & Cheng, V. (2012) Urban human thermal comfort in hot and humid Hong Kong. *Energy and Buildings*, 55, pp. 51-65.

Nice, C. (2010) *How to See, How to Draw: Keys to Realistic Drawing*. Cincinnati, OH, USA, North Light Books.

Nicol, F., Humphreys, M. & Roaf, S. (2012) *Adaptive Thermal Comfort: Principles and practice*. London, UK, Routledge.

Nikolopoulou, M. & Lykoudis, S. (2006) Thermal comfort in outdoor urban spaces: Analysis across different European countries. *Building and Environment,* 41 (11), pp. 1455-1470.

Nikolopoulou, M. & Lykoudis, S. (2007) Use of Outdoor Spaces and Microclimate in a Mediterranean Urban Area. *Building and Environment*, 42 (10), pp. 3691-3707.

Nikolopoulou, M. & Steemers, K. (2003) Thermal comfort and psychological adaptation as a guide for designing urban spaces. *Energy and Buildings*, 35 (1), pp. 95-101.

Nikolopoulou, M. (2004) Outdoor Comfort. In: Steemers , K. and Steane, M. eds. *Environmental Diversity in Architecture*. London, UK, Spon Press, pp. 101-120.

Nikolopoulou, M. (2008) Architecture and outdoor thermal comfort. In: Katzschner, L. ed. *Proceedings of the Workshop: Thermal Comfort in Urban Planning and Architecture under Consideration of Global Climate Change, February 20-21, 2008, Kassel, Germany*. Department of Environmental Meteorology, pp. 31-71. Available from: <https://kobra.bibliothek.uni-kassel.de/bitstream/urn:nbn:de:hebis:34-2008042121208/1/booklet_workshop_kassel_08.pdf> [Accessed 04 January 2015].

Nikolopoulou, M. (2011) Outdoor thermal comfort. *Frontiers in Bioscience*, S3 (4), pp. 1552-1568.

Nikolopoulou, M. et al. (2011) Pedestrians' perception of environmental stimuli through field surveys: focus on particulate pollution. *Science of the Total Environment*, 409 (13), pp. 2493-2502.

Nikolopoulou, M., Baker, N. & Steemers, K (2001) Thermal Comfort in Outdoor Urban Spaces: Understanding the Human Parameter. *Solar Energy,* 70 (3), pp. 227-235.

Nishimura, N. et al. (1998) Novel Water Facilities for Creation of Comfortable Urban Micrometeorology. *Solar Energy*, 64 (4), pp. 197-207.

O'Hare, D. (2006) Urban Walkability in the Subtropical City: Some Intemperate Considerations from SEQ. In: Kennedy, R. ed. *Subtropical Cities 2006 Conference Proceedings: Achieving Ecologically Sustainable Urbanism in a Subtropical Built Environment*, 27 - 29

September 2006, Brisbane, Queensland, Australia, Queensland University of Technology, pp. 131—136. Available from: <http://www.subtropicalcities2006.qut.edu.au/documents/Papers%20Page/Papers/O'Hare%20-%20Urban%20Walkability%20in%20the%20Subtropical%20City.pdf> [accessed 9 January 2011].

Oke, T. (1988) Street Design and Urban Canopy Layer Climate. *Energy and Buildings*, 11 (1-3), pp. 103-113.

Olafson, L., Grandy, C. & Owens, M. (2015) Qualitative Approaches to Studying Teacher's Beliefs. In: Fives, H. & Gill, M. eds. *International Handbook of Research on Teacher Beliefs*. Abingdon, London, UK, Routledge, pp. 128-149.

Özdemir, A. (2013) Designing Landscapes for Child Health. In: Özyavuz, M. ed. *Advances in Landscape Architecture*. Croatia, InTech, pp. 227-262.

Papadimitriou, E., Yannis, G. & Golias, J. (2009) A critical assessment of pedestrian behaviour models. *Transportation research part F: traffic psychology and behaviour*, 12 (3), pp. 242-255.

Parsons, K. (2014) *Human Thermal Environments: The Effects of Hot, Moderate, and Cold Environments on Human Health, Comfort and Performance*. 3rd ed. Boca Raton, FL, USA, CRC Press.

Patton, M. (2002) *Qualitative Research & Evaluation Methods*. 3rd ed. London, UK, Sage Publications Ltd.

Pease, A. & Pease, B. (2004) *The Definitive Book of Body Language*. London, UK, Orion Books Ltd.

Peel, M. et al. (2007) Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences* [Internet], 11, pp. 1633-1644. Available from: <http://www.hydrol-earth-syst-sci.net/11/1633/2007/hess-11-1633-2007.pdf> [Accessed 18 September 2014].

Peil, M, Mitchell, P. & Rimmer, D. eds. (1982) *Social Science Research Methods: An African Handbook*. London, UK, Hodder and Stoughton.

Perry, M. (2000) Car Dependency and Culture in Beirut: Effects of an American Transport Paradigm. *Third World Planning Review* (University of Liverpool), 22 (4), pp. 395-409.

Petritsch, T. (2009) *The Influence of Lane Widths on Safety and Capacity: A Summary of the Latest Findings*. Available from: <http://nacto.org/docs/usdg/lane_widths_on_safety_and_capacity_petritsch.pdf> [Accessed 14 May 2016].

Petruccioli, A. (2007) *After Amnesia: Learning from the Islamic Mediterranean Urban Fabric*. Bari, Italy, ICAR.

Potvin, A. (2004) Intermediate Environments. In: Steemers, K. and Steane, M. ed. *Environmental Diversity and Architecture*. London, UK, Spon Press, pp. 121-142.

Powdermaker, H. (1966) *Stranger and Friend: The Way of an Anthropologist*. NY, USA, W. W. Norton & Company, Inc.

Pregill, P. & Volkman, N. (1993) *Landscapes in History, Design and Planning in the Western Tradition*. NY, USA, Van Nostrand Reinhold.

Presidency of Meteorology and Environment 'PME' (2015) *Seasonal Report for Summer 2015*. Available from: <http://www.pme.gov.sa/SummerReport2015.pdf> [Accessed: 20.08.2015].

Project for Public Spaces (2008) *Streets as Places: Using Streets to Rebuild Communities*. NY, USA, Project for Public Spaces, Inc. Available from: <http://www.pps.org/pdf/bookstore/Using_Streets_to_Rebuild_Communities.pdf> [Accessed 20 June 2014].

Rao, M. et al. (2014) Assessing the relationship among urban trees, nitrogen dioxide, and respiratory health. *Environmental Pollution*, 194, pp. 96-104.

Rapoport, A. (1977) *Human Aspects of Urban Form: Towards a Man-Environment Approach to Urban Form and Design*. Oxford, UK, Pergamon Press Ltd.

Rapoport, A. (1980) Cross-Cultural Aspects of Environmental Design. In: Altman, I. et al. eds. *Human Behavior and Environment: Environment and Culture*. NY, USA, Springer Science+Business Media, LLC, pp. 7-46.

Rapoport, A. (1990a) *The Meaning of the Built Environment: A Nonverbal Communication Approach*. Tucson, AZ, USA, The University of Arizona Press.

Rapoport, A. (1990b) *History and Precedent in Environmental Design*. NY, USA, Plenum Press.

Rapoport, A. (1991) Pedestrian Street Use: Culture and Perception. In Moudon, A.V. ed. *Public Streets for Public Use*. NY, Columbia University Press, pp. 80-92.

Rapoport, A. (1993) Systems of activities and systems of settings. In: Kent, S. ed. *Domestic architecture and the use of space: An interdisciplinary cross cultural study*. Cambridge, UK, Cambridge University Press, pp. 9-20.

Ratti, C., Raydan, D. & Steemers, K. (2003) Building form and environmental performance: archetypes, analysis and an arid climate. *Energy and Buildings*, 35 (1), pp. 49-59.

Relph, E. (1976) *Place and Placelessness*. London, UK, Pion Limited.

Rick, G. (1992) *Landscape Plant Manual for Saudi Arabia*. Jeddah, Saudi Arabia, King Abdulaziz University.

Robitu, M. et al. (2006) Modeling the Influence of vegetation and water pond on urban microclimate. *Solar Energy*, 80 (4), pp. 435-447.

Rohles Jr, F. H. (2007) Temperature & Temperament: A Psychologist Looks at Comfort. *ASHRAE Journal*, 49 (2), pp. 14-22.

Rossi, A. (1984) *The Architecture of the City*. Cambridge, MA, USA, MIT Press.

Rudofsky, B. (1969) *Streets for people: a primer for Americans*. NY, USA, Doubleday.

Sahu, P. (2013) *Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and Other Related Fields*. New Delhi, India, Springer.

Saliba, R. ed. (2015) *Urban Design in the Arab World: Reconceptualizing Boundaries*. Surrey, UK, Ashgate Publishing Ltd.

Salingaros, N. (2005) *Principles of urban structure.* Amsterdam, Techne Press.

Salingaros, N. et al.. (2011) *P2P Urbanism* [Internet]. Solingen, Germany, Umbau-Verlag. Available from: <http://zeta.math.utsa.edu/~yxk833/P2PURBANISM.pdf> [Accessed 26 April 2014].

Sallis, J., Owen, N. & Fisher, E. (2008) Ecological Models of Health Behavior. In: Glanz, K. et al. eds. *Health Behavior and Health Education: Theory, Research, and Practice*. 4th ed. San Francisco, CA, USA, Jossey-Bass, pp. 465-485.

Sanders, D. (1993) Behavioral conventions and archaeology: methods for the analysis of ancient architecture. In: Kent, S. ed. *Domestic architecture and the use of space: an interdisciplinary cross cultural study*. Cambridge, UK, Cambridge University Press, pp. 43-72.

Satterthwaite, D. (2005) *The scale of urban change worldwide 1950-2000 and its underpinnings*. London, UK, IIED (International Institute for Environment and Development). Available from: <http://pubs.iied.org/pdfs/9531IIED.pdf> [Accessed 19 May 2015].

Schlossberg, M. et al. (2013) *Rethinking Streets: An Evidence-Based Guide to 25 Complete Street Transformations, University of Oregon's Sustainable Cities Initiative*. Available from: <http://www.rethinkingstreets.com/> [Accessed 30 May 2014].

Schweizer, C., Racioppi, F. & Nemer, L. (2014) *Developing national action plans on transport, health and environment: A step-by-step manual for policy-makers and planners* [Online].

World Health Organization, Regional Office for Europe. Available from: <http://www.euro.who.int/__data/assets/pdf_file/0010/247168/Developing-national-action-plans-on-transport,-health-and-environment.pdf> [Accessed 20 May 2014].

Sennett, R. (1978) *The Fall of Public Man*. NY, USA, Vintage Books.

Setaih, K., Hamza, N. & Townshend, T. (2013) Assessment of Outdoor Thermal Comfort in Urban Microclimate in Hot Arid Areas. *Proceedings of BS2013: 13th Conference of International Building Performance Simulation Association*, August 26-28, 2013, Chambéry, France, pp. 3153-3160. Available from: <http://www.ibpsa.org/proceedings/BS2013/p_2521.pdf> [Accessed 21 August 2015].

Shaffir, W. & Stebbins, R. eds. (1991) *Experiencing Fieldwork: An Inside View of Qualitative Research*. London, UK, Sage Publications, Inc.

Shahidan, M. (2011) *The Potential Optimum Cooling Effect of Vegetation with Ground Surface Physical Properties Modification in Mitigating the Urban Heat Island Effect in Malaysia*. Phd Thesis, Cardiff University, UK.

Sharmin, T., & Steemers, K. (2015) Use of microclimate models for evaluating thermal comfort: Identifying the gaps. In: *Proceedings of International Conference CISBAT 2015 Future Buildings and Districts Sustainability from Nano to Urban Scale*, September 9-11, Lausanne, Switzerland, pp. 895-900.

Sharmin, T., Kabir, S. & Rahaman, M. (2012) A Study of Thermal Comfort in Outdoor Urban Spaces in respect to Increasing Building Height in Dhaka. *The AIUB Journal of Science and Engineering (AJSE)*, 11 (1), pp. 57-66.

Shashua-Bar, L. et al. (2011) The influence of trees and grass on outdoor thermal comfort in a hot-arid environment. *International Journal of Climatology*, 31 (10), pp. 1498-1506.

Shaughnessy, J., Zechmeister, E. & Zechmeister, J. (2015) *Research Methods in Psychology*. 10th ed. NY, USA, McGraw-Hill Education.

Sheets, V. & Manzer, C. (1991) Affect, cognition, and urban vegetation: some effects of adding trees along city streets. *Environment and Behavior*, 23 (3), pp. 285-304.

Sidawi, B. (2013) Understanding the vocabulary of the Islamic architectural heritage. *Global Built Environment Review*, 8 (2), pp. 26-39.

Simon, J. (2003) *The Art of Empirical Investigation*. NJ, USA, Transaction Publishers.

Sommer, R. & Sommer, B. (2002) *A Practical Guide to Behavioral Research: Tools and Techniques*. 5th ed. NY, USA, Oxford University Press, Inc.

Sommer, R. (1969) *Personal Space: The Behavioral Basis of Design*. Englewood Cliffs, NJ, USA, Prentice-Hall.

Spagnolo, J. & de Dear, R. (2003) A field study of thermal comfort in outdoor and semioutdoor environments in subtropical Sydney Australia. *Building and Environment*, 38 (5), pp. 721-738.

Spradley, J. (2016) *Participant Observation*. IL, USA, Waveland Press, Inc.

Stake, R. (1995) *The Art of Case Study Research*. London, UK, Sage Publications, Inc.

Steane, M. & Steemers, K. (2004) Environmental Diversity in Architecture. In: Steemers, K. and Steane, M. ed. *Environmental Diversity and Architecture*. London, UK, Spon Press, pp. 3-16.

Stern, P. (2000) Towards a coherent theory of environmentally significant behaviour. *Journal of Social Issues*, 56 (3), pp. 407-424.

Stradling, S. (2011) Travel Mode Choice. In: Porter, B. ed. *Handbook of Traffic Psychology*. London, UK, Academic Press, pp. 485-502.

Synnefa, A. et al. (2008) Large Scale Albedo Changes Using Cool Materials to Mitigate Heat Island in Athens. *Journal of Applied Meteorology and Climatology*, 47, pp. 2846-2856.

Synnefa, A. et al. (2011) Experimental Testing of Cool Colored Thin Layer Asphalt and Estimation of its Potential to Improve the Urban Microclimate. *Building and Environment*, 46 (1), pp. 38-44.

Szokolay, S. (2014) *Introduction to Architectural Science: The Basis of Sustainable Design*. 3rd ed. London, UK, Routledge.

Taleghani, M. et al. (2015) Outdoor thermal comfort within five different urban forms in the Netherlands. *Building and Environment*, 83, pp. 65-78.

Tan, C., Wong, N. & Jusuf, S. (2013) Outdoor mean radiant temperature estimation in the tropical urban environment. *Building and Environment*, 64, pp. 118-129.

Tan, E. (2009) What the pedestrian wants. In: Hoeven, F., Smit, M. & Spek, S. eds. *Street-level desires, Discovering the city on foot: Pedestrian mobility and the regeneration of the European city centre*. The Netherlands, TU Delft, pp. 136-141.

Thomas, L. (2012) A really useful source. *Urban Design Group Journal*, 124, Urban Design in the Middle East, pp. 2.

Thompson, C. W., Aspinall, P. & Bell, S. eds. (2010) *Innovative Approaches to Researching Landscape and Health – Open Space: People Space 2*. London, UK, Routledge.

Thompson, C. W. (2013) Activity, exercise and the planning and design of outdoor spaces. *Journal of Environmental Psychology*, 34, pp.79-96.

Thorsson, S. et al. (2007) Different methods for estimating the mean radiant temperature in an outdoor urban setting. *International Journal of Climatology*, 27 (14), pp. 1983-1993.

Tibbalds, F. (1992) *Making People-Friendly Towns: Improving the public environment in towns and cities*. Essex, UK, Longman Group.

Tolley, M. (2015) *The Psychology of Personal Space*. The University of Northampton. Available from: <http://martintolley.com/environment/PersSpaceEnvPsy7.html> [Accessed 04 August 2015].

Topp, H. (1989) Traffic safety, usability and streetscape effects of new design principles for major urban roads. *Transportation*, 16 (4), 297-310.

Torre, L. (1989) *Waterfront Development*. NY, USA, Van Nostrand Reinhold.

Toudert, F. (2005) *Dependence of Outdoor Thermal Comfort on Street Design in Hot and Dry Climate*. PhD thesis, University of Freiburg, Germany.

Toudert, F. & Mayer, H. (2006) *Effects of street design on outdoor thermal comfort*. Available from <http://www2.sci.u-szeged.hu/eghajlattan/baba/Ali-Toudert.pdf> [Accessed 20 Sept 2015].

Trancik, R. (1986) *Finding Lost Space: Theories of Urban Design*. NY, USA, John Wiley & Sons, Inc.

Triandis, H. (1977) *Interpersonal Behaviour*. Monterey, CA, USA, Brooks/Cole.

Tsao, CL. (2007) *A Street Life Project: Walking on main streets in Hsin-Chu City Center, Taiwan*. PhD thesis, Oxford Brookes University, UK.

Tseliou, A. et al. (2010) An evaluation of three biometeorological indices for human thermal comfort in urban outdoor areas under real climatic conditions. *Building and Environment,* 45 (5), pp. 1346-1352.

Tuan, Y. (1977) *Space and Place: the Perspective of Experience*. Minneapolis, University of Minnesota Press.

Turner, A. & Penn, A. (2002) Encoding natural movement as an agent-based system: an investigation into human pedestrian behaviour in the built environment. *Environment and Planning B*, 29 (4), pp. 473-490.

Turner, T. (1996) *City as Landscape: a Post-Postmodern View of Design and Planning*. London, UK, E & FN Spon.

Ulrich, R. (1986) Human responses to vegetation and landscapes. *Landscape and Urban Planning*, 13, pp. 29-44.

Umran, E. (2002) *Development of Khobar waterfront* (in Arabic). Master thesis, King Faisal University, Saudi Arabia.

Urry, J. (2011) Sustainable mobility as a ‘cultural’ challenge [Internet]. *Bonn Symposium 2011 (Mobility-Development-Culture: Towards Sustainable Transport Strategies), December 1-2, Bonn, Germany*. Development and Peace Foundation (SEF) & Deutsche Welle and Haus der Geschichte. Available from: <http://www.sef-bonn.org/fileadmin/Die_SEF/Veranstaltungen/BoSy/2011_bosy_urry_en.pdf> [Accessed 23 December 2014].

Vasilikou, C. & Nikolopoulou, M. (2014) Degrees of Environmental Diversity for Pedestrian Thermal Comfort in the Urban Continuum: A New Methodological Approach. In: Edgerton, E. et al. eds. *Bridging the Boundaries: Human Experience in the Natural and Built Environment and Implications for Research, Policy, and Practice*. Hogrefe Publishing. pp. 97-108.

Walker, J. (2012) *Human Transit: How Clearer Thinking about Public Transit Can Enrich Our Communities and Our Lives*. London, UK, Island Press.

Wall, E. & Waterman, T. (2010) *Basics Landscape Architecture 01: Urban Design*. Switzerland, AVA Publishing SA.

Watson, D. (2013) Bioclimatic Design. In: Loftness, V. & Haase, D. eds. *Sustainable Built Environments*. NY, USA, Springer, pp. 1-30.

Westin, A. (1970) *Privacy and Freedom*. NY, USA, Atheneum.

Whyte, W. (1993) *Street Corner Society: The Social Structure of an Italian Slum*. 4th ed. London, UK, The University of Chicago Press, Ltd.

Whyte, W. (2001) *The Social Life of Small Urban Spaces*. Ann Arbor, Michigan, Project for Public Spaces Inc.

Whyte, W. (2009) *City: Rediscovering the Center*. Philadelphia, PA, USA, University of Pennsylvania Press.

Wolf, K. (2003) Public response to the urban forest in inner-city business districts. *Journal of Arboriculture*, 29 (3), pp. 117-126.

Woodside, A. (2010) *Case Study Research: Theory, Methods, Practice*. Bingley, UK, Emerald Group Publishing Ltd.

Yang, T. & Clements-Croome, D. (2013) Natural Ventilation in Built Environment. In: Loftness, V. & Haase, D. eds. *Sustainable Built Environments*. NY, USA, Springer, pp. 394-425.

Yang, W., Wong, N. & Jusuf, S. (2013) Thermal comfort in outdoor urban spaces in Singapore. *Building and Environment*, 59, pp. 426-435.

Yin, R. (2014) *Case Study Research: Design and Methods*. 5th ed. London, UK, Sage Publications Ltd.

Zacharias, J. (2009) The Pedestrian Itinerary–Purposes, Environmental Factors and Path Decisions. In: Timmermans, H. ed. *Pedestrian Behavior: Models, Data Collection and Applications*. Bingley, UK, Emerald Group Publishing Limited, pp. 283-307.

Zatari, T. et al. (2005) *First National Communication: Kingdom of Saudi Arabia* [Internet]. Report submitted to The United Nations Framework Convention on Climate Change (UNFCCC), Presidency of Meteorology and Environment (PME). Available from: <http://jrcc.sa/reports_files/First_National_Communication_SAUDI_ARABIA.pdf > [Accessed 29 October 2014].

Zatari, T. et al. (2011) *Second National Communication: Kingdom of Saudi Arabia* [Internet]. Report submitted to The United Nations Framework Convention on Climate Change (UNFCCC), Presidency of Meteorology and Environment (PME). Available from: <http://jrcc.sa/reports_files/Second_National_Communication_SAUDI_ARABIA.pdf> [Accessed 29 October 2014].

Zeisel, J. (1984) *Inquiry by design: tool for environment-behavior research*. Cambridge, UK, Cambridge University Press.

Zeisel, J. (2006). *Inquiry by Design: Environment/Behavior/Neuroscience in Architecture, Interiors, Landscape and Planning*. NY, USA, W. W. Norton & Co.

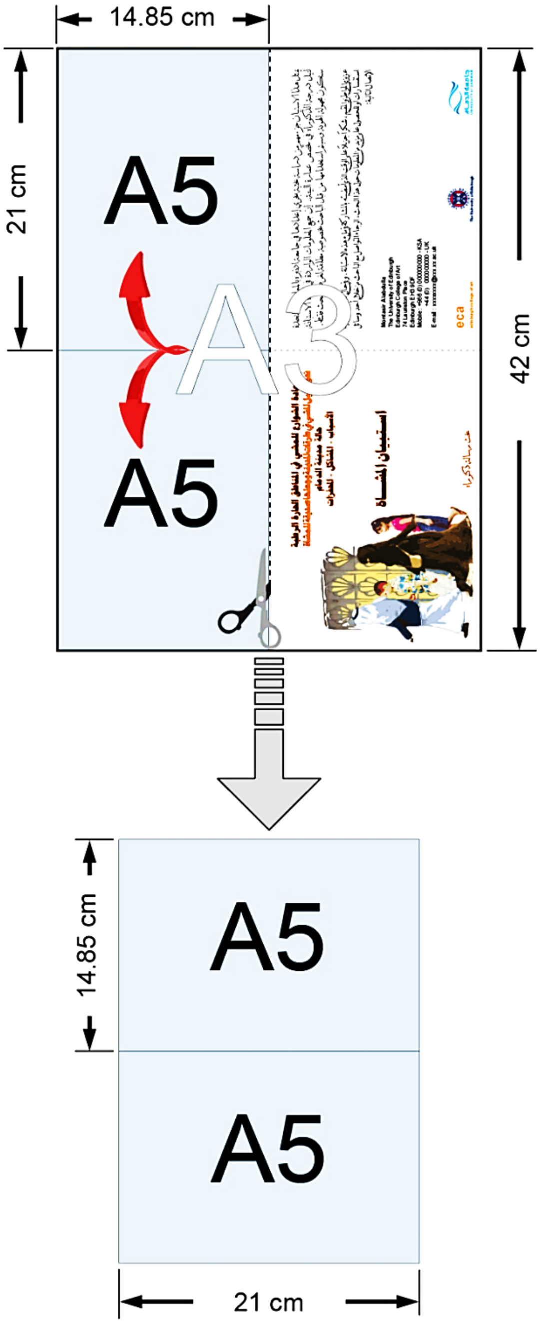
Zukin, S. (2000) *The Cultures of Cities*. Oxford, UK, Blackwell Publishers Ltd.

Appendices

Appendix A

A.1 – The original sample of the interview-based questionnaire (Arabic)

In order to make the original questionnaire - which was primarily printed on A5 size paper in landscape orientation - fits into the standard A4 paper used in this thesis, the author downsized and transformed it into a portrait direction.



A.1.1 - Outer Cover Page

إستعادة الشوارع للمشي في المناطق الحارة الرطبة
نحو تفعيل المشي في طرقات المدينة وجعلها صديقة للمشاة
حالة مدينة الدمام
الأسباب - المشاكل - المحفزات

استبيان المشاة

بحث رسالة دكتوراه

Front Cover

Page Break

يمثل هذا الاستبيان جزء مهم من دراسة بحثية تجري إعدادها في جامعة ادنبره بالمملكة المتحدة لنيل درجة الدكتوراه في تخصص عمارة البيئة. إن جميع المعلومات الواردة في هذه الاستبانة ستكون مجهولة الهوية وسيتم استخدامها من قبل الباحث بخصوصية مطلقة لغرض البحث فقط.

عزيزي المواطن والمقيم، شكراً جزيلاً على الوقت الذي أمضيته بالمشاركة في ملء هذه الاستبانة. وفي حال كانت لديك أية استفسارات أو للحصول على مزيد من المعلومات حول هذا البحث، الرجاء التواصل مع الباحث من خلال أحد وسائل الإتصال التالية:

Montasir Alabdulla
The University of Edinburgh
Edinburgh College of Art
74 Lauriston Place
Edinburgh EH3 9DF
Mobile : +966 (0) 000000000 - KSA
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eca
edinburgh college of art

The University of Edinburgh

جامعة الدمام
UNIVERSITY OF DAMMAM

Back Cover

A.1.2 - Inner Cover Page

عزيزي المواطن / المقيم
السلام عليكم ورحمة الله وبركاته،،،

أرجو المشاركة في دراسة بحثية يجري إعدادها في جامعة ادنبره بالمملكة المتحدة للحصول على درجة الدكتوراه في تخصص عمارة البيئة. هذا البحث - والذي أعدت هذه الاستبانة من أجله - هو بادرة تهدف لتشجيع نمط حياة أكثر نشاطاً وصحة واستدامة من خلال التعرف على العناصر والمحفزات (العوامل التسهيلية) التي يمكن تطويرها أو إضافتها في حيز الشارع ومن شأنها تشجيع تغيير سلوك تنقل السكان في المناطق الحارة الرطبة نحو مزيد من المشي في طرقات المدينة دون الحاجة للسيارة ، حالة مدينة الدمام. هذه الاستبانة مصممة بحيث لا تأخذ من المشارك لإكمالها أكثر من ١٠ **دقائق**، على أكثر تقدير، إذا كنت مستعد وترغب بالمشاركة.

الإجابة على جميع أسئلة هذه الاستبانة هي مشاركة تطوعية تماما وليس من ورائها أي منفعة أو ضرر عند اختيارك بالمشاركة أو عدمه. بينما يقوم الباحث بأخذ القياسات المناخية الأساسية (في حال توزيع الاستمارات في المناطق الخارجية) ، سوف تتفضل بملء الاستمارة بما في ذلك بعض الإحصاءات الديموغرافية لأغراض توصيفيه. إلا أنه لن يكون بمقدور أي شخص، حتى الباحث نفسه، في أي وقت من الأوقات على تحديد هوية المشارك. الاستبانة المكتملة سيتم مناقشتها فقط من قبل الباحث والمشرفين على رسالة الدكتوراه: الدكتور سيمون بيل، والدكتور كريس سبيد. كما أن إجاباتك سوف تستخدم فقط في إجراء المقارنات والعلاقات التبادلية مع أجوبة المشاركين الآخرين، وبالتالي البيانات المجمعة فقط سوف يجرى لها عملية التحليل ومن بعد ذلك تلخيص النتائج في الأطروحة النهائية.

إن تعاونك مع الباحث والمصداقية في الإجابة بدقة على أسئلة هذا الاستبيان سوف يكون له بالغ الأثر بالمساعدة في توجيه صناعة القرار المتعلق بتصميم وإدارة شوارع المدن السعودية والدمام خاصة لتحديد خصائص وسمات التطوير الضرورية في حيز الشارع لجعل المشي سلوك وممارسة يومية - لغايات متعددة وليس فقط كنشاط رياضي لفوائد صحية - في المجتمع السعودي المعاصر ولمواكبة متطلبات الإستدامة الحضرية المستقبلية.

الباحث/ منتصر العبدالله
محاضر بكلية العمارة والتخطيط - جامعة الدمام

Inside Front Cover

Page Break

نبذة عن البحث:

من البديهي أن ما يجعل أي مدينة مكاناً نابضاً بالحياة، هو تواجد الناس في المناطق الخارجية بحيث يستطيعون ممارسة أنشطتهم اليومية بحرية في أي مكان وفي أي وقت. والمشاة، تحديداً، هم كينونة التمدن وجوهر التحضر فوجودهم أو عدمه هو مؤشر يدل على جودة الحيز الحضري. وليس هناك مكان عام حيث يمكن للإنسان بأن يشعر بهذه الحيوية أفضل من الشارع. فالشوارع الحضارية هي تلك الأماكن العامة التي تلبي احتياجات جميع مستخدميها، ورغباتهم و تطلعاتهم. إلا أن هناك عدة عوامل لاتزال تؤثر على اتخاذ الفرد القرار بالمشي أو القيادة (في ظل غياب وسائل نقل بديلة) والتي أدت في نهاية المطاف إلى انخفاض معدلات المشي في شوارع الدمام وتزايد ثقافة الاعتماد على السيارة - حتى إلى أقرب الوجهات مثل محلات البقالة - مما جعلها نمطاً معيشياً مرحب به والخيار الأسهل للمجتمع، وخاصة في ظل ظروف مناخية تتسم بالقساوة.

كما أن نهج التطوير الذي تشهده شوارع الدمام منذ السنوات الأخيرة كان في المقام الأول لخدمة مصالح سائقي السيارات مع حلول متواضعة وغير صديقة للمشاة. فحيز الشارع بتكوينه التخطيطي والتصميمي الحالي لا يأخذ في الحسبان بشكل كاف أهمية ممارسة المشي اليومي على صحة الإنسان أو توفير بيئة أمنة ومريحة وممتعة للمشي. وبالتالي، فقد تزايد توجه معظم السكان إلى بدائل أخرى، وتحديداً، مراكز التسوق والصالات الرياضية المكيفة. لذلك، تطور مفهوم الشوارع الصديقة للمشاة، في كثير من دول العالم، من مجرد اهتمام بسيط ليصبح ظاهرة تؤثر على ملايين البشر كون الأنسان هو العنصر الذي يشكل قاعدته. تستند هذه النظرية على فكرة تهيئة بيئة الشارع بطريقة تتيح للمجتمع اختيارهم لوسيلة التنقل المرغوبة وجعل المشي خيارهم الأول لبعض رحلات السيارة القصيرة. بالرغم من ذلك، مازال هذا المفهوم في المملكة مسألة مهملة تقتصر على مسارات المشي والتي أنشئت كمشاريع مستقلة بذاتها مماثلة لمراكز التسوق أو الواجهات البحرية التي تستلزم قيادة السيارة للوصول اليها وممارسة المشي.

من ناحية أخرى، تشير الدراسات إلى أن رغبات أو توجهات وتفضيلات الأفراد وممارساتهم لا تبقى ثابتة على مر السنين نتيجة لتأثير عدة عوامل، كما لا يمكن أن يفرض التغيير على أي مجتمع. لذلك، فإن تغيير سلوك وممارسات المجتمع السعودي الاعتيادية - من قيادة السيارة تجاه المزيد من الاعتماد على المشي - هو مسألة تحتاج إلى تدخل عوامل تسهيل وتيسير ملائمة. مثل هذه التدخلات ينبغي أن تبنى وفقا لمواقف وتفضيلات الأفراد تجاه قضية المشي، وطرق تحقيق الراحة الحرارية والعوامل المجتمعية من أجل تخفيف حدة مقاومتهم للتغيير. وهذا يعني أن تغيير السمات والخصائص المبنية الموجودة في حيز الشارع هي ذات أهمية حاسمة لإحداث أي تغيير في هذا السلوك الروتيني. لأن القرار الذي سيتخذه الفرد سواء بالمشي أو القيادة يعتمد على كيفية إبراز وتقديم الخيارات المتاحة لهذا الشخص وإلى أي مدى هذه البدائل قادرة على تشجيع ودعم نمط حياة على أخر.

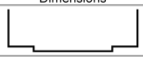
Inside Back Cover

A.1.3 – Original Questionnaire Form (page 1 and 2)

QR # **PET (°C):**

Date: / / 2012 **Time:** : **am / pm** **City:** .... **NHD:** ....

*** Site:**

Street	Orientation	Dimensions	Spatial Characteristics
			□ Shaded Area □ Exposed to Solar Radiation □ Planted Area

Walking Track	Waterfront	Shopping Mall	School	University	Mosque	Others

*** Meteorological Data:**

Air Temperature [Ta (°C)]	Globe Temperature [Tg (°C)]	R. Humidity (RH%)	Wind Velocity (m/s)	Mean Radiant Temperature [Tmrt (°C)]

الجزء الأول - البيانات الشخصية :

١. الجنس : □ ذكر □ أنثى **٢. الجنسية:** □ سعودي □ غير سعودي

٣. الفئة العمرية: □ <١٠ سنوات □ ١٠ - ٢٠ □ ٢١ - ٣٠ □ ٣١ - ٤٠ □ ٤١ - ٥٠ □ ٥١ - ٦٠ □ > ٦٠ سنة

٤. الوزن: .... كجم **٥. الطول:** .... سم

٦. ماذا كنت تفعل خلال الـ ١٥ دقيقة الماضية (النشاط البدني الممارس) :
□ نوم □ جلوس □ بيع □ وقوف □ صلاة □ مشي
□ هرولة / جري □ أعمال بناء □ أخرى: ....

٧. ماذا أكلت أو شربت خلال الـ ١٥ دقيقة الماضية :
□ بدون □ وجبة خفيفة □ وجبة كاملة
□ مشروب بارد □ مشروب ساخن □ أخرى: ....

٨. أين كنت خلال الـ ١٥ دقيقة الماضية (بيئة التواجد) :
□ مكان داخلي □ مكان خارجي

٩. الملابس:

□ Ghutra / Shemagh □ Emma	□ Cap □ Hat	□ None
□ Sleeveless Shirt □ Underwear Shirt □ Coloured T-Shirt	□ L. Sleeve. Shirt □ Blouse □ Vest	□ Jacket □ Pak. Blouse
□ Pants □ Sunna trouser □ Walking Short	□ Normal trouser □ Jeans □ wizra	□ White Thobe □ Coloured Thobe □ Pak. Trouser
□ Shoes & Socks	□ Sandal	□ Thongs

1

Page Break

١٠. الحالة الوظيفية : □ طالب □ موظف بدوام كامل □ موظف نص دوام □ أعمال خاصة □ متقاعد □ غير متوظف

١١. هل تستخدم السيارة (من قبل أي فرد من أفراد الأسرة) للوصول إلى أي مكان للمشي ؟ □ نعم □ لا

١٢. إذا كنت الإجابة بنعم، كم عدد السيارات المستخدمة بشكل يومي : □ ١ - ٢ □ ٣ - ٤ □ ٥ - ٦ □ ٦ +

الجزء الثاني - قياس الراحة الحرارية الخارجية :

١٣. كيف تشعر حاليا ؟

□ حران كثير	□ حران	□ دافئ	عادي	□ بردان شوي	□ بردان	□ بردان كثير

١٤. هل ترغب في تعديل درجة الحرارة الآن ؟

زيادة كثيرة (+٣)	زيادة أكثر قليلاً (+٢)	زيادة خفيفة (+١)	**دون تغيير**	تقليل خفيف (-١)	تقليل أكثر قليلاً (-٢)	تقليل كثير (-٣)

١٥. كيف تفضل سرعة الهواء الأن ؟ □ حركة هواء أكثر □ بدون تغيير □ حركة هواء أقل

١٦ كيف تفضل نسبة الرطوبة الأن ؟ □ رطوبة أكثر □ بدون تغيير □ رطوبة أقل

١٧. كيف تفضل مستوى الظل الأن ؟ □ ظل أكثر □ بدون تغيير □ ظل أقل

١٨. هل مارست المشي خلال الأشهر الثلاثة الماضية [عندما كانت الأحوال الجوية معتدلة] :

□ في الكورنيش بقصد المشي فقط	□ بشكل متكرر جداً	□ قليلاً	□ لم يحدث أبداً
□ في أحد المجمعات التجارية بقصد المشي فقط	□ بشكل متكرر جداً	□ قليلاً	□ لم يحدث أبداً
□ في شوارع المدينة (سواء داخل الحي أو في الشوارع الرئيسية)	□ بشكل متكرر جداً	□ قليلاً	□ لم يحدث أبداً
□ في أحد ممرات المشي المنتشرة في بعض أحياء الدمام	□ بشكل متكرر جداً	□ قليلاً	□ لم يحدث أبداً

الجزء الثالث - قياس الجوانب الاجتماعية والثقافية والسلوكية للمشاة :

١٩. كم مرة في الأسبوع تمارس المشي ؟ □ ولا مرة □ ١ - ٢ مرة □ ٣ - ٤ مرات □ ٥ - ٦ مرات □ > ٦ مرات

٢٠. كم تستغرق من الوقت في كل مرة ؟ □ < ٥ دقائق □ ٥ - ١٠ دقائق □ ١٠ - ٣٠ دقيقة □ ٣٠ دقيقة - ١ ساعة □ > ١ ساعة

2

A.1.3 – Original Questionnaire Form (page 3 and 4)

٢١. إذا كنت تمارس أو تريد ممارسة المشي، ما هي الأسباب والدوافع :

- □ الرغبة والاستمتاع بالرياضة (للصحة العامة)
- □ ترفيه وترويح عن النفس (للخروج من ضغوطات العمل / الدراسة)
- □ أسباب صحية (حمل ، السمنة المفرطة، مرض السكري ، أمراض القلب)
- □ للالتقاء بالأصدقاء بعيداً عن المنزل
- □ للتسوق
- □ كوسيلة تنقل (بما في ذلك زيارة الجيران / الوصول للخدمات القريبة)
- □ أخرى (أذكر) : ....

٢٢. مع من تذهب / تريد الذهاب للمشي ؟

- □ بمفردك
- □ مع أحد الأقارب
- □ مع صديق
- □ مع مجموعة أصدقاء
- □ أخرى (أذكر) : ....

٢٣. أين تفضل ممارسة المشي ؟

- □ في بيئة داخلية
- □ في بيئة خارجية
- □ السبب : ....

....

....

....

....

٢٤. ما هو الوقت المفضل لديك للمشي ؟ □ صباحاً □ بعد الظهر □ بعد العصر □ بعد المغرب □ بعد العشاء □ لا يوجد وقت محدد

٢٥. هل تشعر بان قرب المسافة الشخصية من الآخرين له تأثير على استخدامك للأرصفة للمشي ؟ □ موافق بشدة □ موافق □ حيادي □ غير موافق □ غير موافق بشدة

٢٦. ماهي مسافة البعد عن الأخرين المفضلة (تشعرك بالراحة / الأمان) للمشي ؟ □ ≥ ١,٢م □ ١,٢ - ١,٥م □ ١,٥ - ٢م □ ٢ - ٢,٥م □ > ٢,٥م □ غير مهم

٢٧. عند قيادتك للسيارة، هل يزعجك أن لا تجد موقفاً أمام وجهتك المنشودة ؟ □ نعم □ لا السبب : ....

٢٨. إذا كانت أحوال الطقس معتدلة وكانت لديك النية بالمشي، ماهي احتمالية قيامك بالمشي <u>فعلياً</u> ؟ □ محتمل جداً □ محتمل □ حيادي □ مستبعد □ مستبعد جداً

٢٩. هل تتوقع توفر وسائل نقل عامة حديثة ستكون محفزاً لاستعادة المشي في الشوارع ؟ □ محتمل جداً □ محتمل □ حيادي □ مستبعد □ مستبعد جداً

٣٠. إذا كنت تسير / ترغب في ممارسة المشي في الخارج، هل ستفضل إنشاء المزيد من ممرات المشي أو تهيئة الشارع أكثر ؟ □ ممرات أكثر □ تهيئة الشارع

السبب : ....

	موافق بشدة	موافق	حيادي	غير موافق	غير موافق بشدة
٣١. هل تعتقد أن للأسرة والأصدقاء دور قد يشجعك تجاه المشي ؟	□	□	□	□	□
٣٢. وفقا لتجربتك الشخصية ، هل تظن الزي التقليدي (التوب الأبيض والعباءة السوداء) قد يقلل من فرصك بالمشي ؟ السبب :	□	□	□	□	□
٣٣. إذا كنت تمشي في اماكن غير الشارع ، هل السبب للابتعاد عن المعاكسات والاحتكاك المباشر مع الرجال/ النساء ؟	□	□	□	□	□
٣٤. هل صحيح أن الأشخاص المهمين بالنسبة لك يعتقدون أن المشي سلوك حضاري ونشاط طبيعي ؟	□	□	□	□	□
٣٥. هل استمرار رخص البنزين سيجعلك غير مهتم لتحسين جودة الشارع للمشي في المستقبل ؟	□	□	□	□	□
٣٦. اذا تم تهيئة أرصفة الشوارع للمشي؛ هل سيكون لديك رغبة واستعداد لتغيير نمط حياتك بالعودة للمشي في الشارع ؟	□	□	□	□	□

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الجزء الرابع - قياس الرضا عن خصائص و مكونات الشارع :

	موافق بشدة	موافق	حيادي	غير موافق	غير موافق بشدة
٣٧. هل توافق على أن سوء حالة الأرصفة (مكسرة أو متشققة) عاملاً أساسياً في ابتعادك عن المشي ؟	□	□	□	□	□
٣٨. هل تعتقد عرض الأرصفة في كثير من شوارع الدمام غير كافي للمشي ؟	□	□	□	□	□
٣٩. هل ترى محاولات السكان بالتشجير على الأرصفة ساهمت في تضييق مساحة المشي المخصصة ؟	□	□	□	□	□
٤٠. هل تشعر بالانزعاج من تعديات السكان بإيقاف سياراتهم أو مظلات السيارات على الأرصفة إلى درجة ترفض المشي ؟	□	□	□	□	□
٤١. هل تؤيد أن ليس هناك تدابير حماية كافية في شوارع الدمام تفصل بين حركة المشاة والسيارات ؟	□	□	□	□	□
٤٢. هل تعتبر ألوان وخامات الرصف المستخدمة مكررة في كل شارع مما يجعل من تجربة المشي مملة ؟	□	□	□	□	□
٤٣. هل غياب شوارع مظللة (بالأشجار أو المظلات) هو السبب الحقيقي الذي يجعل تجربة المشي غير مرغوبة ؟	□	□	□	□	□
٤٤. هل تعتبر المسافة بين الخدمات الأساسية (بقالة ، مخبز ، صيدلية ...إلخ) والمنزل أبعد مما تستطيع المشي إليه ؟	□	□	□	□	□
٤٥. هل غياب مناطق عبور للمشاة ضمن شوارع الحي تعمل على تقليل رغبتك في المشي ؟	□	□	□	□	□
٤٦. هل توافق بأن قلة أو غياب المطبات الصناعية داخل الأحياء يمنعك من المشي ؟	□	□	□	□	□
٤٧. هل تعتبر أماكن اللوحات الإعلانية أو الإرشادية وأعمدة الإضاءة وصناديق القمامة موضوعة بطريقة تعوق المشي ؟	□	□	□	□	□
٤٨. هل ترى شكل الشارع ممل بسبب عشوائية مقاسات اللوحات الإعلانية للمحلات وكثافة الكتل الخرسانية ؟	□	□	□	□	□
٤٩. هل تزويد الأرصفة بمقاعد جلوس سيشجعك بالمشي إلى الخدمات القريبة من منزلك ؟	□	□	□	□	□
٥٠. هل تعتقد لإنارة الشوارع دور في ابتعادك عن استخدام الشارع للمشي ؟	□	□	□	□	□
٥١. هل توصي بتزويد الشوارع بدورات مياه ؟	□	□	□	□	□
٥٢. هل ترى تزويد الشوارع بكاميرات مراقبة لرصد التعديات على المشاة سيشجعك على المشي ؟	□	□	□	□	□
٥٣. هل تؤيد ترقيم طول الأرصفة باعتباره عاملا مساهما يشجعك على استخدامها ؟	□	□	□	□	□
٥٤. هل تعتبر توفر الحدائق والملاعب داخل الحي دافع يقودك الى المشي اليها ؟	□	□	□	□	□
٥٥. هل تؤيد فكرة تزويد الشوارع بوسائل تبريد للهواء تعمل تلقائياً عند زيادة الرطوبة أو انخفاض سرعة الهواء ؟	□	□	□	□	□

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A.2 – The original questionnaire (English version)

A.2.1 - Outer Cover Page

Reclaiming Urban Streets for Walking in a Hot and Humid Region:
Towards Reactivating Walking on Urban Streets
The Case of Dammam City, Saudi Arabia

Pedestrians Questionnaire

PhD Research

Front Cover

Page Break

Dear citizen / resident, this questionnaire is an essential part of research being conducted at Edinburgh College of Art, The University of Edinburgh in the UK, to obtain a PhD Degree in Landscape Architecture. All information received from this questionnaire will be anonymous, confidential and used only for research purposes.

Thank you very much for taking the time to participate in filling this questionnaire. In case you have any questions or for further information about this research, please contact the researcher using any of the following details:

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The University of Edinburgh
Edinburgh College of Art
74 Lauriston Place
Edinburgh EH3 9DF
Mobile : +966 (0) 000000000 - KSA
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eca edinburgh college of art

The University of Edinburgh

جامعة الدمام UNIVERSITY OF DAMMAM

Back Cover

A.2.2 - Inside Front Cover Page (Translated - English)

Dear citizen/ resident
Assalamu Alaikum,,,

You are kindly invited to participate in a research being conducted at The University of Edinburgh, UK, for obtaining a PhD degree in Landscape Architecture. The researcher seeks to document your opinion about how significant the renovation processes that Dammam streets have experienced may hinder or support your intention to walk along urban streets. This study is an initiative aims to encourage a more active and healthier lifestyle.

This research, for which this questionnaire was prepared, is your opportunity to inform decision-makers, developers and professionals involved in urban streets design about what is working to keep, what is frustrating to remove or replace and what you believe is missing that should be introduced. This could be done through identifying the facilitating conditions that the street environment can offer and would encourage change of behaviour towards more walking. It also intends to gain a more in-depth understanding of the salient attitudes and socio-cultural factors that you have towards making walking your first choice for short distances. The gathered responses will positively help the researcher identifying these attributes, which in turn would assist to improve the current and future urban streets in Saudi for walking.

Filling in this questionnaire is completely voluntary, and the form should not take long to complete, i.e. it is estimated to take approximately **10 minutes**, *at most*. All questions are multiple choices that can be answered with a tick, but there are also opportunities for you to add your own comments. Your cooperation will certainly make a great difference, and if you would like to participate please complete this form as honestly and carefully as possible.

Please note that at no time will anyone, including the researcher, be able to identify who you are. The completed questionnaires will **only** be discussed by the researcher and his supervisors. Your answers will only be looked at in comparison with other participants' responses, which will be reported in the final dissertation.

In case you are looking for further information, you can read "About the research" overleaf. Should you have any questions about this research or the researcher, please contact the researcher using any of the details on the back cover.

Thank you in advance,

Montasir Alabdulla
PhD Candidate

A.2.2 - Inside Back Cover Page (Translated - English)

About the research:

It is self-evident that what makes any city a vibrant place is the existence of people who can practice their daily activities freely anywhere at any time. Pedestrians, in particular, are the entity and essence of urbanisation; their presence or absence is an indicator of the quality of urban spaces. There is no better public space where someone can feel this vitality than streets. Civilised streets are those urban places that provide their users' needs, desires and expectations. However, there are several factors still influence the individual in making the decision to walk or drive, which ultimately led to the decline of walking in Dammam's streets and increase of car dependency 'automatically', even to nearby grocery stores. Thus, car has become a welcomed lifestyle and the easiest choice by the society, especially in harsh climatic conditions.

The development approach of which Dammam's streets are still witnessing since the last four years is primarily to serve the interests of motorists with modest and unfriendly solutions for pedestrian. The street environment in the Kingdom, in its current design and configuration, does not sufficiently take into account the importance of daily walking on human health or provide a safe, comfortable and pleasant environment for walking. Consequently, most of people have shifted to other alternatives; namely, air-conditioned shopping malls and gyms. Therefore, the concept of pedestrian-friendly streets has evolved in many countries of the world from a simple interest to become a phenomenon affects millions of people given that its nature is based on the human dimension. It aims to creating the street environment in a way allows the community to choose the desired mode of travel and making walking their first choice for short car journeys. In the Kingdom, however, this concept is still a neglected issue confined to walking paths that are being constructed as stand-alone projects similar to shopping malls or waterfront developments in terms of the need to drive a car to reach a destination to practice walking.

Moreover, studies indicate that individuals' attitudes, preferences and practices do not remain constant over the years due to the influence of several factors, besides that change cannot be imposed on any society. Therefore, changing Saudis' habitual behaviour (driving) towards more walking is in need of adequate facilitating conditions. Such interventions should be constructed according to people's attitudes, preferences, comfort and social factors in order to alleviate their 'resistance to change'. This implies that changing the existing physical attributes of streets is of crucial importance to produce behaviour change. Because the decision to be made by an individual whether to walk or drive depends on how the available choices are presented to that person and to what extent these alternatives are capable of fostering a lifestyle over the other.

A.2.3 – Questionnaire Form (Translated - English)

QR # ☐ **PET (°C):** ☐

Date: / / 2012 **Time:** : am / pm **City:** .... **NHD:** ....

*** Site:**

Street	Orientation	Dimensions	Spatial Characteristics
			☐ Shaded Area ☐ Exposed to Solar Radiation ☐ Planted Area

Walking Track	Waterfront	Shopping Mall	School	University	Mosque	Others

*** Meteorological Data:**

Air Temperature [Ta (°C)]	Globe Temperature [Tg (°C)]	R. Humidity (RH%)	Wind Velocity (m/s)	Mean Radiant Temperature [Tmrt (°C)]

PART *I* - Data of the Participant:

1. Gender: ☐ Male ☐ Female **2. Ethnicity:** ☐ Saudi ☐ Non-Saudi

3. Age ▼ Group: **4. Weight:** .... kg. **5. Height:** .... cm

☐ < 20
☐ 21 - 30
☐ 31 - 40
☐ 41 - 50
☐ 51 - 60
☐ > 60

6. Activity - (Within last 15 min):

☐ Sleeping ☐ Sitting
☐ Selling ☐ Standing
☐ Praying ☐ Walking
☐ Jogging ☐ Cons. Works
☐ Other: ....

7. Foods and Drinks (Within last 15 min)

☐ None ☐ Snack
☐ Meal ☐ Cold Drink
☐ Hot Drink ☐ Other: ....

8. Previous Environment (Last 15 min):

☐ Indoor
☐ Outdoor

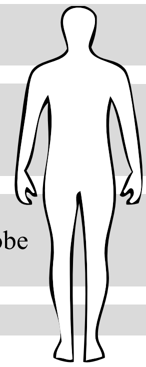
9. Clothing:

☐ Ghutra / Shemagh ☐ Cap ☐ None
☐ Emma ☐ Hat

☐ Sleeveless Shirt ☐ L. Sleeve. Shirt ☐ Jacket
☐ Underwear Shirt ☐ Blouse ☐ Pak. Blouse
☐ Coloured T-Shirt ☐ Vest

☐ Pants ☐ Normal trouser ☐ White Thobe
☐ Sunna trouser ☐ Jeans ☐ Coloured Thobe
☐ Walking Short ☐ Wizra ☐ Pak. Trouser

☐ Shoes and Socks ☐ Sandal ☐ Thongs



10. Employment Status:

☐ Student ☐ Full-time employment ☐ Part-time employment
☐ Self-employed ☐ Retired ☐ Unemployed

11. Car use (by any member of the family) to reach any walking environment: ☐ Yes ☐ No

12. If you marked yes, how many are used on a daily basis? ☐ 1 – 2 ☐ 3 – 4 ☐ 5 – 6 ☐ +6

PART *II* - Measuring Outdoor Thermal Comfort *(Sensation Vote)*:

13. How do you **currently** feel?

Cold	Cool	Slightly Cool	Neutral	Warm	Hot	Very Hot

14. Do you want to adjust the temperature **now**?

Much Decrease (-3)	More Decrease (-2)	Slight Decrease (-1)	No Change (0)	Slight Increase (+1)	More Increase (+2)	Much Increase (+3)

15. Wind preferences now? □ Less Air Movement □ No Change □ More Air Movement

16. Humidity preferences now? □ Less Humidity □ No Change □ More Humidity

17. Shading preferences now? □ More Shade □ No Change □ Less Shade (if sunny)

18. Have you walked during the last three months [when climatic conditions were temperate] in one of the following spaces: * ***Please mark the scale value that best reflects your answer***

□	Corniche area with the intention to walk only	□ Very Frequently	□ Not Often	□ Never
□	Shopping mall with the intention to walk only	□ Very Frequently	□ Not Often	□ Never
□	Streets (in neighbourhoods or major streets)	□ Very Frequently	□ Not Often	□ Never
□	Any walking track in Dammam	□ Very Frequently	□ Not Often	□ Never

PART *III* - Measuring Socio-Cultural and Behavioural Aspects:

19. How often do you walk per week? □ None □ 1 - 2 □ 3 - 4 □ 5 - 6 □ > 6

20. How long you walk every time? □ < 5min □ 5 - 10 □ 10 - 30 □ 30 - 60 □ > 60 min

21. If you walk or intend to, what might be your purposes / motives to do so?

□ For sport and general health (Desire and enjoyment of practicing the physical activity)
□ For recreation (to get rid of the pressures of work / study)
□ For health reasons (pregnancy, obesity, diabetes, heart disease)
□ For social interaction (meeting friends outside)
□ For shopping, food and drink
□ As a mean of transport (visiting neighbours / nearby services, going to work/ school)

22. With whom you go for a walk?
□ Alone
□ Group

23. Where would you prefer to practice walking?
□ Indoor Environment Why? ....
□ Outdoor Environment Why? ....

24. What is your favourite time to walk outdoor?

□ Morning □ Afternoon □ Late Afternoon □ After Sunset □ At Night □ Unspecified

25. Do you feel and accept the physical proximity (personal distance) from others has an impact on your use of pavements for walking?

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1	2	3	4	5

26. How far the preferred distance to walk from others on pavements *(e.g. to feel comfortable / safe)*?

□ ≤ 1.2 m □ 1.2 - 1.5 m □ 1.5 - 2 m □ 2 - 2.5 m □ > 2.5 m □ Unspecified

27. Is it annoying if you cannot find a parking space in front of your desired destination?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Why? ....

28. If the weather is temperate and you have an intention to walk, what is the probability to actually walk?

Very Likely	Somewhat Likely	Not Sure	Somewhat Unlikely	Very Unlikely
1	2	3	4	5

29. Do you expect running highly efficient modern public transport (reliable, flexible and comfortable) can be a stimulating system to restore walking on streets?

Very Likely	Somewhat Likely	Not Sure	Somewhat Unlikely	Very Unlikely
1	2	3	4	5

30. If you walk outdoor, would you prefer constructing more walking tracks or develop streets more?

□ Construct more walking tracks □ Develop streets more

Why? ....

31. Do you think your family and friends have a role may encourage you to walk?

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1	2	3	4	5

32. Based on your experience, do you see the traditional costume (white Thobe and black Abaya) may reduce opportunities for walking?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Why? ....

33. If you walk anywhere but not streets, are you doing this to avoid being seen walking; to avoid flirtations or even to move away from direct contact with men / women?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

34. Is it true that most important people to you believe walking is a civilized behaviour and normal activity?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

35. Do you think continuity of the cheap gasoline will make you unconcerned in improving streets for walking in the future?

Very Likely	Somewhat Likely	Neutral	Somewhat Unlikely	Very Unlikely
1	2	3	4	5

36. If pavements were reclaimed conveniently for walking; will you have the desire and willingness to change your lifestyle to return to walk on streets?

Highly Likely	Somewhat Likely	Neutral	Somewhat Unlikely	Highly Unlikely
1	2	3	4	5

PART *IV* - Measuring Urban Streets Physical and Spatial Attributes:

*** *Please mark the scale value that best reflects your personal answer***

37. To what extent you believe the poor conditions of pavements (e.g. cracked; uneven levels) are a key factor hinders your walking on streets?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

38. Do you consider width of the pavements in Dammam is too narrow to accommodate your walking needs?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

39. Do you see neighbours' practices by planting on pavements have contributed in narrowing the dedicated space for walking?

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1	2	3	4	5

40. Do you feel disturbed by the encroachments of residents (e.g. parking their cars or erecting carports on pavements) to an extent makes you refrain to walk on streets?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

41. Do you support that there is a lack of adequate protection measures to segregate pedestrians' movement from vehicles in Dammam streets?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

42. Do you think the used materials and colours of pavements are duplicated in most streets, which may make frequent walking a boring experience?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

43. Do you consider the lack of shaded streets is the underlying reason for your withdrawal from streets?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

44. Do you see the distance between your place of residence and the basic daily services (grocery, bakery, pharmacy, etc.) is farther than what you can walk to?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

45. Is it true the lack of regularly distributed pedestrian crossing zones along neighbourhood streets works to lessen your desire to use streets for walking?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

46. Do you agree the lack of speed bumps within local streets may discourage you to walk on streets?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

47. Do you consider placement of streetscape elements (e.g. billboards, direction signs, lighting poles, garbage bins) on pavements interfere with your walk?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

48. Do you see streets unattractive environment for walking owing to the excessive use of concrete and shop signs look random and inconsistent?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

49. Do you think pavements equipped with benches may encourage you to use streets for walking?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

50. Do you think the standard street lighting plays a role in your reluctance to walk on streets?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

51. Would you recommend that streets to be equipped with public toilets?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

52. Do you believe streets equipped with surveillance cameras make you feel safe, and thus may encourage you to walk?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

53. Do you support marking pavements with distances (length of the pavement) as a contributing factor to use them for walking?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

54. Do you consider the availability of parks and playgrounds within neighbourhoods will motivate you to walk?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

55. Do you support incorporating ventilation systems, operate automatically when humidity increases or wind speeds decrease, into streets?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

Appendix B

B.1 – Fieldwork Data Collection Permits (Arabic)

B.1.1 - A scanned copy of the authorisation letter from the Emirate of the Eastern Province, to the concerned authorities

إمارة المنطقة الشرقية
رقم الصادر :٣٦٠٩١
تاريخ الصادر :١٤٣٣/٠٥/٢٣
المشفوعات:

المملكة العربية السعودية
وزارة الداخلية
إمارة المنطقة الشرقية

(٠٠٥)

إدارة الخدمات العامة

الموضوع/ تسهيل مهمة المحاضر/ منتصر العبدالله
لإجراء بحثه لدرجة الدكتوراه

صورة مع التحية لمعالي/ مدير جامعة الدمام... للاحاطة.
سعادة/ مدير عام فرع الرئاسة العامة لهيئة الأمر بالمعروف والنهي عن المنكر بالمنطقة الشرقية
سعادة/ مدير شرطة المنطقة الشرقية
سعادة مدير عام التربية والتعليم بالمنطقة الشرقية

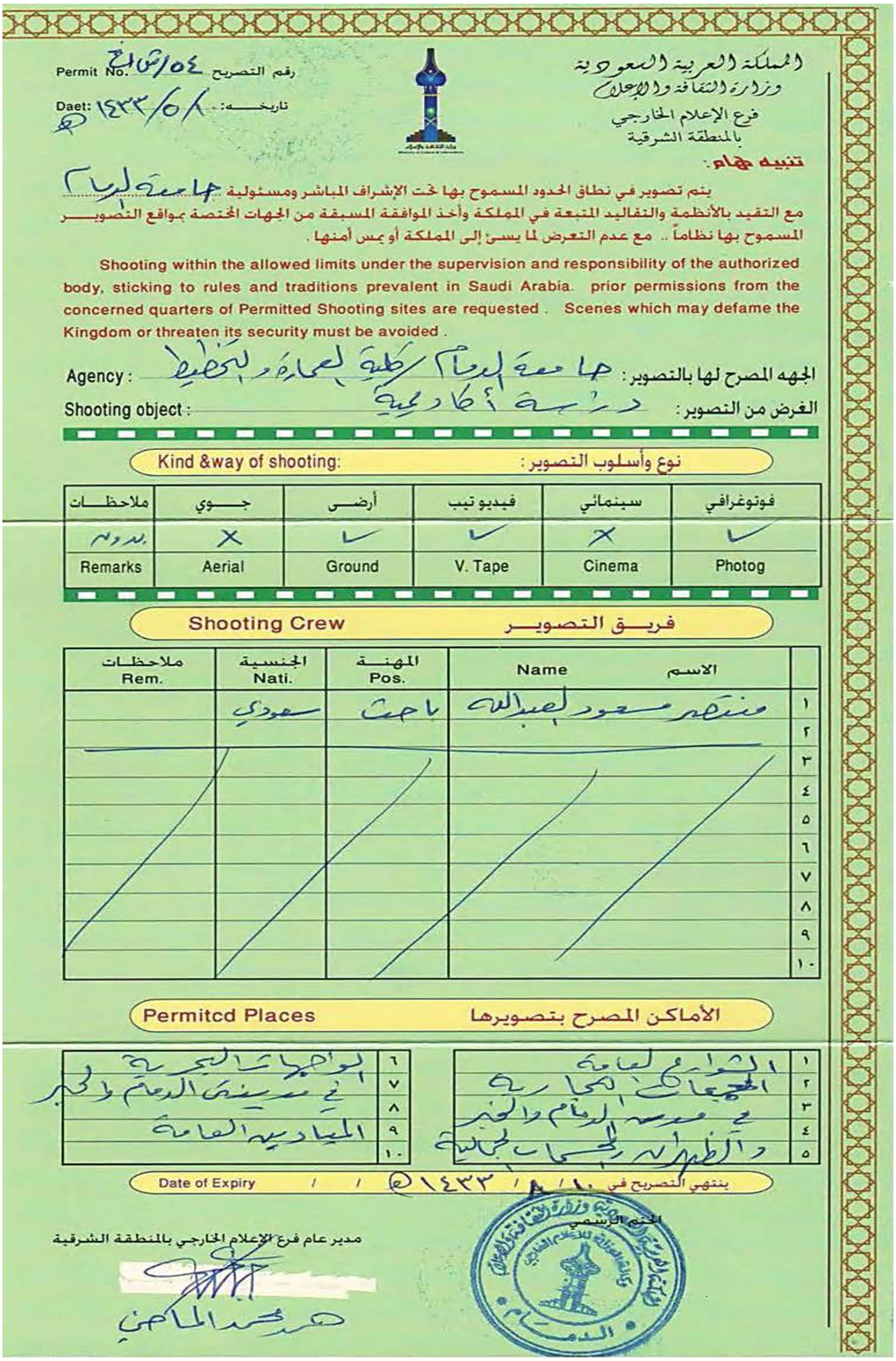
السلام عليكم ورحمة الله وبركاته
إشارة لخطاب جامعة الدمام رقم ٩/٤٢/٢/٥٠٥ بتاريخ ١٤٣٣/٥/٨هـ بشأن طلبهم تسهيل مهمة المحاضر / منتصر بن مسعود العبدالله والمبتعث للحصول على درجة الدكتوراه عن بحثه بعنوان (تغيير سلوك تنقل الانسان في المناطق الحارة الرطبة نحو مزيد من المشي - حالة مدينة الدمام) والمتمثلة بتصوير وأخذ عينات وإجراء إستبيان للمستخدمين في الشوارع وبعض المجمعات التجارية والمدارس الابتدائية (بنين) والواجهات البحرية في مدن الدمام والخبر والجبيل.
لذا نود تسهيل مهمته ومساعدته ليكمل إجراءات بحثه.
ولكم تحياتنا.،،

وكيل امارة المنطقة الشرقية
زارب بن سعيد القحطاني

ح.هـ

www.sharqiah.gov.sa

B.1.2 – A scanned copy of permission for indoor and outdoor photography, issued by the Ministry of Culture and Information



المملكة العربية السعودية
وزارة الثقافة والإعلام
فرع الإعلام الخارجي
بالمنطقة الشرقية

Permit No. ٥٤/ش/خ رقم التصريح
Daet: ١٤٣٣/٥/٨ هـ تاريخــــه:

تنبيه هام :

يتم تصوير في نطاق الحدود المسموح بها تحت الإشراف المباشر ومسئولية جامعة الدمام مع التقيد بالأنظمة والتقاليد المتبعة في المملكة وأخذ الموافقة المسبقة من الجهات المختصة بمواقع التصوير المسموح بها نظاماً .. مع عدم التعرض لما يسيئ إلى المملكة أو يمس أمنها .

Shooting within the allowed limits under the supervision and responsibility of the authorized body, sticking to rules and traditions prevalent in Saudi Arabia. prior permissions from the concerned quarters of Permitted Shooting sites are requested . Scenes which may defame the Kingdom or threaten its security must be avoided .

Agency : جامعة الدمام / كلية العمارة والتخطيط :الجهه المصرح لها بالتصوير
Shooting object : دراسة أكاديمية :الغرض من التصوير

Kind &way of shooting: نوع وأسلوب التصوير :

فوتوغرافي	سينمائي	فيديو تيب	أرضــي	جـــوي	ملاحظــات
✓	✗	✓	✓	✗	بدون
Photog	Cinema	V. Tape	Ground	Aerial	Remarks

Shooting Crew فريــق التصويــر

	الاسم Name	المهنــة Pos.	الجنسية Nati.	ملاحظات Rem.
١	منصور سعود العبدالله	باحث	سعودي	
٢				
٣				
٤				
٥				
٦				
٧				
٨				
٩				
١٠				

Permitcd Places الأماكن المصرح بتصويرها

١	الشوارع العامة	٦	الواجهات البحرية
٢	المجمعات التجارية	٧	في مدينة الدمام والخبر
٣	في مدينة الدمام والخبر	٨	
٤		٩	الميادين العامة
٥	والظهران والجبيل	١٠	

Date of Expiry / / ١٤٣٣/٨/١٠ هـ ينتهي التصريح في

مدير عام فرع الإعلام الخارجي بالمنطقة الشرقية

فهد محمد المالكي

الختم الرسمي

B.1.3 – A scanned copy of the permit for data collection at Dhahran Mall

10:00 AM

مجمع الظهران
Mall of Dhahran

Work Permit تصريح عمل

Type of Job	نوع العمل	
CONSTRUCTION	أعمال بناء	
SHOP FITTING	أعمال بناء	
STOCK DELIVERY	إدخال بضاعه	
STOCK REMOVAL	أخراج بضاعه	
Inventory / Shop Arrangement	جرد بضاعه + ترتيب المحل	
Maintenance Inside the shop	اعمال صيانه داخل المعرض	
Others	لامانع من التصوير داخل المجمع	أخرى: @

Dear Security Supervisor — السيد / مشرف الأمن

given to: جامعة الدمام :أعطي هذا التصريح إلى

with the following number of staff 2 وبرفقته العدد التالي من العمال

To do the job(s) marked above. للقيام بالأعمال المبينه أعلاه.

Time of work أوقات العمل

	To إلى	From من	
Fist Period	03:00 ع	09:00 ص	الفتره الأولى
Second Period			الفتره الثانيه

Effective Starting إبتداء من

To إلى		From من	
Date التاريخ	Day اليوم	Date التاريخ	Day اليوم
	يوم واحدفقط لاغير	17/5/2012	الخميس

Entry/ Exit is allowed through gate		جميع البوابات	يسمح للهم بالدخول والخروج من بوابه
Remarks		حسب موافقة م/محمد كرمول	ملاحظات

Instructions	التعليمات
1) Not allowed to use (Hyper Panda - Centrepint) trolley penalty 1000 SR.	1) يمنع استخدام عربات هايبر بنده يترتب عليها غرامة مالية 1000 ريال.
2) The Mall isn't responsible about any thing inside constitution shop.	2) المجمع غير مسؤول عند أغراض أي محل تحت الإنشاء.
3) Not allowed to evacuation the shop without Management knowing.	3) يمنع إخلاء المحل بدون علم مسبق لإدارة المجمع
4)Not allowed to smoking inside the Mall penalty 300 SR.	4) يمنع التدخين داخل المجمع يترتب عليها غرامة مالية 300 ريال.
5)You Must follow up the date & time of permit otherwise permit is void and take by the security.	5) يجب الالتزام بمواعيد التصريح وخلاف ذلك يعتبر التصريح ملغي ويسحب من قبل إدارة الأمن.

Management Approval		موافقة إدارة المجمع
Person who ordered the permit		Signature التوقيع
		فراس السرور

C.C Security Management صورة إلى إدارة الأمن

Operations Managers مدراء العمليات

Customer Service

1

17/5 2012

Appendix C

C.1 – A scanned copy of the official correspondence letter between the University of Dammam and the selected primary school (Arabic)

MINISTRY OF HIGHER EDUCATION | وزارة التعليم العالي
UNIVERSITY OF DAMMAM | جامعة الدمام

جامعة الدمام
UNIVERSITY OF DAMMAM
(٠٤٣)

سعادة مدير المدرسة الأستاذ/ المحترم

مجمع الأمير سعود بن نايف القسم الابتدائي

السلام عليكم ورحمة الله وبركاته

مع أطيب التحيات أشير لسعادتكم بأن المحاضر / منتصر بن مسعود العبد الله مبتعث لدرجة الدكتوراه بالمملكة المتحدة وهو بصدد تجميع بعض المعلومات الضرورية الخاصة بموضوع بحثه.

نفيد سعادتكم برغبته القيام بتوزيع استبيانات في المدرسة لديكم و المتعلقة بموضوع البحث الذي يجريه.

فنرجو من سعادتكم الإيعاز لمن يلزم لمساعدته في تسهيل مهمته.

وتقبلوا فائق التحية والتقدير ،،،

عميد كلية العمارة والتخطيط

أ.د عبد السلام بن علي السديري

جامعة الدمام
UNIVERSITY OF DAMMAM
كلية العمارة والتخطيط
College of Architecture and Planning

الرقم:
التاريخ:
المشفوعات:

المملكة العربية السعودية الدمام 31441 Dammam ص . ب P.o Box 1982
Tel. +966 3 8577000 سنترال Fax. +966 3 8578048 www.ud.edu.sa info@ud.edu.sa

مطابع جامعة الدمام
UNIVERSITY OF DAMMAM PRINTING PRESS

C.2 – A scanned copy of the original letter of parental consent for their children to participate in the questionnaire (Arabic), issued by the selected school

بسم الله الرحمن الرحيم

المملكة العربية السعودية
وزارة التربية والتعليم
الإدارة العامة للتربية والتعليم بالمنطقة الشرقية
مجمع الأمير سعود بن نايف التعليمي بالدمام
القسم الابتدائي

وزارة التربية والتعليم
Ministry of Education

الرقـــم : ....
التـــاريخ : ....
المرفقات : ....

المكرم ولي أمر الطالب : ....

السلام عليكم ورحمة الله وبركاته وبعد :

يعتزم أحد الباحثين بجامعة الدمام في تخصص عمارة البيئة والمبتعث للحصول على درجة الدكتوراه من المملكة المتحدة عن بحثه بعنوان (تغيير سلوك تنقل الانسان في المناطق الحارة الرطبة نحو مزيد من المشي - حالة مدينة الدمام) بزيارة المدرسة ولقاء بعض الطلبة للتعرف و تحديد مدى ملائمة بيئة شوارع المدينة للمشي من وجهة نظر ابنائنا الطلاب . يتمثل هذا اللقاء بمقابلة الطلاب - خلال أحد رحلات المدرسة التعليمية أو الزيارات الميدانية الخارجية ضمن أنشطة هذا العام - وتوزيع استمارات الاستبيان عليهم بهدف قياس مستوى رضاهم عن بيئة الشارع الحضري للمشي ، كما سيتضمن هذا اللقاء أخذ بعض الصور الفوتوغرافية لأغراض البحث فقط . هذا وسوف يتم اللقاء بحضور أحد المعلمين وإشراف مدير المدرسة .

مما لاشك فيه ، أن مثل هذه الابحاث تمثل أهمية بالغة لتناولها قضايا بحثية معاصرة تساهم في تقدم الوطن وتطوره عمرانياً . علاوة على ذلك ، تعتبر مثل هذه التجربة بمثابة وسيلة تعليمية عملية لأبنائنا الطلبة على التعرف على أحد الوسائل المستخدمة لجمع المعلومات البحثية ، وفرصة جديرة بالتجربة تسمح للطلاب بمناقشة الباحث الذي يمثل مصدر جديد بالنسبة اليهم للتعرف على أحد التخصصات الهندسية التي تقدمها الجامعات السعودية مما قد يساعدهم في تحديد رغباتهم المهنية مستقبلاً .

كما ونؤكد لكم حرص المدرسة على اتخاذ الاحتياطات والتعهدات اللازمة من قبل الباحث بتجنب طرح أية أسئلة شخصية (متعلقة بالأسرة) على الطلاب ، علماً بأن جميع اجابات الاسئلة التي سيدلي بها الطلاب ستظل سرية ومجهولة الهوية وستستخدم لأغراض البحث العلمي فقط . وفي حال رغبتم بالحصول على نسخة من نموذج الاستبيان ، يرجى الإشارة في الحقل المناسب ادناه .

لذا ومن مبدأ التعاون مع الباحثين وتسهيل مهمتهم بما يعود بالنفع والمصلحة العامة على الوطن ، آمل ابداء رأيكم بالموافق أو الممانعة على مشاركة ابنكم .

(..........) موافق (.........) غير موافق

□ ارسال نسخة من استمارة الاستبيان

أسم ولي الأمر : .... رقم الجوال : ....

التوقيع : .... التاريخ : ....

مدير المدرسة

هاتف : 8469941-013 ~ فاكس : 8430015-013 ~ الموقع الالكتروني : www.edueast.gov.sa

C.3 – Translation of the parental consent letter (English)

Dear Parent/ Guardian,

This is to inform you that there is a researcher, from the Landscape Architecture Dept. at the University of Dammam, intends to visit our school and meet with a group of pupils to collect necessary data for his PhD research that is being conducted at the University of Edinburgh, UK. The aim of this visit is to measure levels of satisfaction/ dissatisfaction with the current conditions of urban streets in Dammam for walking in order to identify opportunities and constraints that support or hinder walking from the standpoint of children.

As you may already be aware that such a research area represents a contemporary issue that may contribute to a better development of the Saudi urban environment and most of all is the health of the society. In addition, this visit serves as a practical educational means and an opportunity worth the experience allows the pupils to get to know one of the most common and widely used scientific methods for data collection. It also provides a good source for our pupils to explore the role and nature of one of the architectural disciplines.

Participation in this activity is completely voluntary, and will be carried out during one of the outdoor visits, through which your child will be asked to fill in a questionnaire. Please be advised that the experience involves taking photos. In this regard, we assure you that the school is keen to take all necessary precautions by the researcher to avoid any private or personal questions, knowing that all answers and photos will remain confidential, anonymous and will be used for research purposes only. Therefore, the whole period will be in the presence of at least one teacher, and under a direct supervision of the head teacher.

So, based on the principle of cooperation with researchers to facilitate their activities for the benefit of the public interest, I hope to express your decision about your child's participation, whether you agree or disagree. In case you wish to get a copy of the questionnaire form, please tick the box below before your reply.

Yours sincerely

Head teacher

I give my permission for my child, ..., to participate in this survey including photography. (............) YES (............) NO

☐ Send me a copy of the questionnaire. * Mobile Number: ....

....

Parent/Guardian Signature Date

Appendix D - Tables used for the calculation of the PET

D.1 – A standard list of clothing insulation values (Source: McCullough et al., 1984: 41-43)

Design Description and Fabric Type	Garment Weight (kg)	Body Surfaces Area Covered (%)	f_{cl}	I_{cle} (clo)	I_{cl} (clo)
Shirts					
Long-sleeve, bow at neck (broadcloth)	0.206	52	1.13	0.25	0.33
Long-sleeve, shirt collar (broadcloth)	0.196	51	1.12	0.25	0.33
Long-sleeve, shirt collar (flannel)	0.309	51	1.12	0.34	0.42
Short-sleeve, shirt collar (broadcloth)	0.156	43	1.10	0.19	0.25
Short-sleeve, sport shirt (double knit)	0.228	40	1.02	0.17	0.18
3/4 length sleeve, boat neck* (broadcloth)	0.142	46	1.11	0.27	0.34
Cap sleeve, boat neck* (broadcloth)	0.113	36	1.09	0.21	0.27
Sleeveless, scoop neck (broadcloth)	0.117	30	1.08	0.13	0.18
Tube top (double knit)	0.067	12	1.01	0.06	0.07
Long-sleeve, sweat shirt (fleece-backed knit)	0.284	45	1.06	0.34	0.38
Sweaters					
Long-sleeve, V-neck (thin knit)	0.215	44	1.04	0.25	0.28
Long-sleeve, V-neck cardigan (thin knit)	0.215	39	1.04	0.23	0.26
Short-sleeve, V-neck (thin knit)	0.188	35	1.04	0.20	0.23
Short-sleeve, V-neck cardigan (thin knit)	0.188	30	1.04	0.17	0.20
Sleeveless, V-neck (thin knit)	0.130	28	1.03	0.13	0.15
Long-sleeve, round neck (thick knit)	0.424	45	1.06	0.36	0.40
Long-sleeve, round neck cardigan (thick knit)	0.424	39	1.06	0.31	0.35
Sleeveless, round neck (thick knit)	0.301	29	1.04	0.22	0.25
Long-sleeve, turtleneck (thin knit)	0.231	47	1.05	0.26	0.29
Long-sleeve, turtleneck (thick knit)	0.459	47	1.06	0.37	0.41
Suit Jackets and Vests (lined)					
Single-breasted suit jacket (denim)	0.518	50	1.12	0.36	0.44
Single-breasted suit jacket (tweed)	0.652	50	1.12	0.44	0.52
Double-breasted suit jacket (denim)	0.562	50	1.13	0.42	0.50
Double-breasted suit jacket (tweed)	0.702	50	1.13	0.48	0.56
Work jacket (duck)	0.885	55	1.21	0.39	0.51
Vest (denim)	0.150	21	1.05	0.10	0.13
Vest (tweed)	0.185	21	1.05	0.17	0.20
Trousers and Coveralls					
Straight, long, fitted (denim)	0.298	45	1.09	0.15	0.21
Straight, long, fitted (tweed)	0.404	45	1.09	0.24	0.30
Straight, long, loose (denim)	0.354	45	1.20	0.20	0.32
Straight, long, loose (tweed)	0.459	45	1.20	0.28	0.40
Walking shorts(denim)	0.195	25	1.06	0.08	0.12
Walking shorts (tweed)	0.251	25	1.06	0.17	0.21
Short shorts (denim)	0.164	18	1.05	0.06	0.09
Sweat pants (fleece-backed knit)	0.345	44	1.10	0.28	0.34
Work pants (duck)	0.832	46	1.21	0.24	0.36
Overalls (denim)	0.854	55	1.18	0.30	0.41
Coveralls (gabardine)	0.995	81	1.21	0.49	0.61
Insulated coveralls (multicomponent)	1.313	81	1.23	0.96	1.09
Skirts					
A-line, ankle length (denim)	0.284	45	1.34	0.23	0.41
A-line, ankle length (tweed)	0.378	45	1.34	0.28	0.46
A-line, 6" below knee (denim)	0.288	40	1.25	0.18	0.32
A-line, 6" below knee (tweed)	0.384	40	1.25	0.25	0.39
A-line, 6" above knee (denim)	0.179	28	1.12	0.10	0.18
A-line, 6" above knee (tweed)	0.238	28	1.12	0.19	0.27
A-line, knee length (denim)	0.229	35	1.18	0.14	0.25
A-line, knee length (tweed)	0.305	35	1.18	0.23	0.34

continued

Design Description and Fabric Type	Garment Weight (kg)	Body Surfaces Area Covered (%)	f_{cl}	I_{cle} (clo)	I_{cl} (clo)
Straight, knee length, with slit (denim)	0.194	34	1.15	0.14	0.23
Straight, knee length, with slit (tweed)	0.259	34	1.15	0.22	0.31
Bias flair, knee length (denim)	0.286	35	1.22	0.13	0.26
Bias flair, knee length (tweed)	0.380	35	1.22	0.22	0.35
Full gathered, knee length (denim)	0.271	35	1.19	0.14	0.25
Full gathered, knee length (tweed)	0.359	35	1.19	0.22	0.33
Knife pleated, knee length (denim)	0.410	35	1.19	0.16	0.27
Knife pleated, knee length (tweed)	0.539	35	1.19	0.26	0.37
Dresses					
Long-sleeve, shirt collar, A-line (broadcloth)	0.254	69	1.21	0.32	0.44
Long-sleeve, shirt collar, A-line (tweed)	0.280	69	1.21	0.47	0.59
Long-sleeve, shirt collar, A-line, belt (broadcloth)	0.283	69	1.18	0.35	0.46
Long-sleeve, shirt collar, A-line, belt (tweed)	0.327	69	1.18	0.48	0.59
Short-sleeve, shirt collar, A-line, belt (broadcloth)	0.237	61	1.15	0.29	0.38
Sleeveless, scoop neck, A-line (broadcloth)	0.153	48	1.19	0.23	0.34
Sleeveless, scoop neck, A-line (tweed)	0.414	48	1.19	0.27	0.38
Sleepwear					
Long-sleeve, long gown (tricot)	0.260	81	1.49	0.29	0.52
Long-sleeve, long gown (flannel)	0.435	81	1.49	0.46	0.69
Long-sleeve, short gown (tricot)	0.180	66	1.25	0.24	0.38
Long-sleeve, short gown (flannel)	0.305	66	1.25	0.39	0.53
Short-sleeve, long gown (tricot)	0.239	74	1.44	0.25	0.47
Short-sleeve, short gown (tricot)	0.157	59	1.20	0.21	0.33
Sleeveless, long gown (tricot)	0.217	65	1.42	0.20	0.41
Sleeveless, short gown (tricot)	0.138	50	1.18	0.18	0.29
Thin strap, long gown (tricot)	0.157	58	1.33	0.18	0.36
Thin strap, short gown (tricot)	0.094	42	1.12	0.15	0.23
Hospital gown (print cloth)	0.270	57	1.23	0.31	0.44
Long-sleeve, long pajamas (broadcloth)	0.327	80	1.30	0.48	0.64
Long-sleeve, long pajamas (flannel)	0.447	80	1.30	0.57	0.73
Short-sleeve, long pajamas (broadcloth)	0.297	71	1.26	0.42	0.57
Long pajama trousers (broadcloth)	0.149	45	1.20	0.17	0.29
Body sleeper with feet (knit fleece)	0.599	86	1.38	0.72	0.92
Robes					
Long-sleeve, wrap, long (velour)	0.690	80.5	1.40	0.53	0.73
Long-sleeve, wrap, long (terrycloth)	1.196	80.5	1.43	0.68	0.89
Long-sleeve, wrap, long (pile knit)	1.535	80.5	1.47	1.02	1.25
Long-sleeve, wrap, short (broadcloth)	0.298	68	1.24	0.41	0.55
Long-sleeve, wrap, short (velour)	0.556	68	1.25	0.46	0.60
3/4 length sleeve, wrap, short (velour)	0.514	63	1.20	0.43	0.55
Long-sleeve, button front, long (broadcloth)	0.268	82	1.47	0.43	0.66
Long-sleeve, button front, long (velour)	0.586	82	1.48	0.49	0.72
Long-sleeve, button front, short (broadcloth)	0.260	69	1.32	0.40	0.57
Long-sleeve, button front, short (velour)	0.472	69	1.33	0.45	0.63
Short-sleeve, button front, short (broadcloth)	0.231	61	1.28	0.34	0.50
Underwear/Footwear					
Briefs (knit)	0.065	12	1.01	0.04	0.05
Panties (tricot)	0.027	12	1.01	0.03	0.04
Bra (knit/foam)	0.044	5	1.01	0.01	0.02
Half slip (tricot)	0.065	32	1.11	0.14	0.21
Full slip (tricot)	0.082	40	1.12	0.16	0.24
T-shirt (knit)	0.105	32	1.03	0.08	0.10
Thermal long underwear top (knit)	0.200	49	1.06	0.20	0.24
Thermal long underwear bottoms (knit)	0.210	44	1.06	0.15	0.19
Pantyhose(knit)	0.039	51**	1.00	0.02	0.02
Ankle length athletic socks (knit)	0.049	7	1.01	0.02	0.03
Calf length athletic socks (knit)	0.082	14	1.01	0.03	0.04
Calf length dress socks (knit)	0.053	13	1.01	0.03	0.04
Knee socks (thick knit)	0.068	20	1.01	0.06	0.07
Thongs/sandals (vinyl)	0.346	5	1.01	0.02	0.03
Hard-soled street shoes (vinyl)	1.006	7	1.03	0.02	0.04
Slippers (quilted fleece)	0.186	9	1.04	0.03	0.06
Soft-soled athletic shoes (canvas)	0.182	7	1.03	0.02	0.04

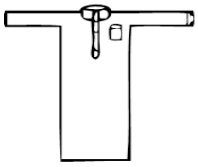
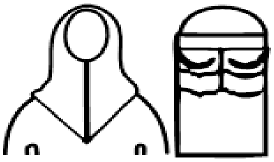
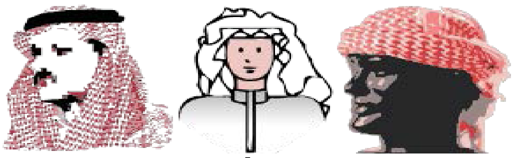
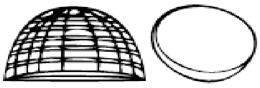
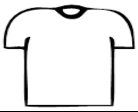
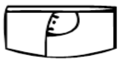
* These shirts are cut fuller than the others for a loose fit.
** In the regression analysis, 12% BSAC was used because only the panty provided insulation.

Typical clothing insulation values (Source: ASHRAE, 2009: 9.9)

Garment Description[a]	$I_{clu,i}$, clo[b]	Garment Description[a]	$I_{clu,i}$, clo[b]	Garment Description[a]	$I_{clu,i}$, clo[b]
Underwear		Long-sleeved, f annel shirt	0.34	Long-sleeved (thin)	0.25
Men’s briefs	0.04	Short-sleeved, knit sport shirt	0.17	Long-sleeved (thick)	0.36
Panties	0.03	Long-sleeved, sweat shirt	0.34	**Dresses and skirts[c]**	
Bra	0.01	**Trousers and Coveralls**		Skirt (thin)	0.14
T-shirt	0.08	Short shorts	0.06	Skirt (thick)	0.23
Full slip	0.16	Walking shorts	0.08	Long-sleeved shirtdress (thin)	0.33
Half slip	0.14	Straight trousers (thin)	0.15	Long-sleeved shirtdress (thick)	0.47
Long underwear top	0.20	Straight trousers (thick)	0.24	Short-sleeved shirtdress (thin)	0.29
Long underwear bottoms	0.15	Sweatpants	0.28	Sleeveless, scoop neck (thin)	0.23
Footwear		Overalls	0.30	Sleeveless, scoop neck (thick)	0.27
Ankle-length athletic socks	0.02	Coveralls	0.49	**Sleepwear and Robes**	
Calf-length socks	0.03	**Suit jackets and vests (lined)**		Sleeveless, short gown (thin)	0.18
Knee socks (thick)	0.06	Single-breasted (thin)	0.36	Sleeveless, long gown (thin)	0.20
Panty hose	0.02	Single-breasted (thick)	0.44	Short-sleeved hospital gown	0.31
Sandals/thongs	0.02	Double-breasted (thin)	0.42	Long-sleeved, long gown (thick)	0.46
Slippers (quilted, pile-lined)	0.03	Double-breasted (thick)	0.48	Long-sleeved pajamas (thick)	0.57
Boots	0.10	Sleeveless vest (thin)	0.10	Short-sleeved pajamas (thin)	0.42
Shirts and Blouses		Sleeveless vest (thick)	0.17	Long-sleeved, long wrap robe (thick)	0.69
Sleeveless, scoop-neck blouse	0.12	**Sweaters**		Long-sleeved, short wrap robe (thick)	0.48
Short-sleeved, dress shirt	0.19	Sleeveless vest (thin)	0.13	Short-sleeved, short robe (thin)	0.34
Long-sleeved, dress shirt	0.25	Sleeveless vest (thick)	0.22		

[a]“Thin” garments are summerweight; “thick” garments are winterweight. [b]1 clo = 0.88°F · ft^2 · h/Btu [c]Knee-length

D.2 – Typical traditional Gulf clothing for males and females, (Source: the author, after Al-Ajmi et al., 2008: 409 – 410)

Body Area Covered	Gender	Image	Garment Description
Whole Body	Female		Black Abaya, Hijab, Burqa, Bra, Pants, Jeans and Sandals
	Male		White or Coloured Thobe
Upper	Female	 a. b.	a. Hijab on head b. Burqa on face
	Male	 a. b. c.	a. Shemagh (red-patterned) and Eqal on head b. Ghutra (white) and Eqal on head c. Emma on head
		 d. e.	d. Hat 'Taqia' e. Eqal
Mid-Upper	Male		Underwear T-Shirt
Mid-Lower	Male		Pants/ briefs
			Underwear Sunna: 'Short Serwal' (white) loose trunks or boxers-like
			Sunna trouser: 'Long Serwal' (white)
Lower	Male		Shoes & Socks; Sandal; Thongs; Slippers

Characteristics of the typical traditional Gulf clothing (*male - female*), (Source: Al-Ajmi et al., 2008: 411)

Ensemble type	Gender	Type/constructio 'Clothing ensemble'	Body surface area covere (%)	Fibre/content	Ensemble weight (kg)
Summer clothing	MALE	Underwear-pants	12	100% cotton	0.108
		Underwear-shirt with 1/3 sleeves	40	100% cotton	0.121
		Short trouser (short Serwal)	25	Polyester, cotton	0.125
		Long trouser (long Serwal)	44	Polyester, cotton	0.181
		Summer Thowb	81	Cotton, wool, polyester	0.419
		Kuffiya (or Taqia)	03	Cotton, polyester, nylon	0.017
		While Ghutra	10	Cotton, silk, polyester	0.130
		Sandal(s) or slippers	04	Leather	–
Winter clothing		Thowb or dishdasha	81	Wool	0.594
		Long sleeve cotton trouser	44	Cotton	0.181
		Kuffiya (or Taqia)	04	Cotton	0.017
		White/Red Qhutra or Shemagh	10	Wool, polyester	0.194
		Eqal	02	Wool	0.117
		Coat or thermo-coat (or Jacket)	64	52% Polyester, 29% viscose, 19% cotton	0.904
		Socks	14	Cotton, polyester	–
		Shoes	7	Leather	–
'Traditional' clothing—'winter'	FEMALE	Winter Daraa	81	Velvet, wool	0.578
		Abaya	86	Polyester	0.665
		Long trousers	51	Polypropylene	0.215
		Shiala	12	Polyester	0.071
		Burqa	7	Polyester	0.022
		Bra	5	Nylon	0.049
		Pants	15	Cotton	0.028
		Socks	20	Cotton, polyester	0.054
		Shoes	9	Leather	–
'Traditional' clothing—'summer'		Summer Daraa	81	Polyester–cotton	0.213
		Shiala	12	Polyester	0.071
		Burqa	7	Polyester	0.022
		Abaya	86	Polyester	0.665
		Bra	5	Nylon	0.049
		Pants	15	Cotton	0.028
		Sandals	4	Leather	–
'Islamic' clothing—'winter'		Winter Daraa	81	Cotton, polyester	0.713
		Long trousers	51	Polypropylene, cotton	0.215
		Pants	15	Cotton	0.028
		Bra	5	Nylon	0.049
		Hijab	12	Polyester	0.062
		Socks	20	Cotton, polyester	0.054
		Shoes	9	Leather	–
'Islamic' clothing—'summer'		Summer Daraa	81	Cotton	0.213
		Hijab	12	Polyester	0.062
		Pants	15	Cotton	0.028
		Bra	5	Nylon	0.049
		Sandals	4	Leather	–

Values of the typical traditional Gulf clothing insulation (*male - female*), (Source: Al-Ajmi et al., 2008: 413 - 414)

Ensemble type/code	Clothing ensembles	f_{cl}	I_a		I_{cl}		I_T	
			clo	$m^2\,°C\,W^{-1}$	clo	$m^2\,°C\,W^{-1}$	clo	$m^2\,°C\,W^{-1}$
Male—summer clothing	Underwear-shirt with 1/3 sleeves, Short sleeve trouser, Thowb, Sandals	1.30	0.594	0.092	0.59	0.092	1.05	0.163
	Underwear-shirt with 1/3 sleeves, Short trouser, Thowb, Kuffiya, White Ghutra, Eqal, Sandals	1.35	0.594	0.092	0.69	0.107	1.13	0.175
	Underwear-shirt with 1/3 sleeves, Short trouser, Long trouser, Thowb, Kuffiya, White Ghutra, Eqal, Sandals	1.36	0.594	0.092	0.79	0.123	1.23	0.191
Male—winter clothing	Underwear-shirt with 1/3 sleeves, Short trouser, Long cotton trouser, Thowb, Kuffiya, Ghutra Shemagh, Egal, Shoes	1.46	0.594	0.092	0.84	0.131	1.25	0.194
	Underwear-shirt with 1/3 sleeves, Short trouser, Long cotton trouser, Thowb, Ghutra Shemagh, Egal, Jacket, Shoes	1.45	0.594	0.092	1.29	0.200	1.70	0.264
'Islamic' Clothing — Summer	Summer Daraa, Shiala, Bra, Pants, Sandals	1.48	0.60	0.092	0.80	0.123	1.20	0.186
	Summer Daraa, Hijab, Bra, Pants, Sandals	1.48	0.60	0.092	0.80	0.123	1.20	0.186
'Islamic' Clothing' — Winter	Winter Daraa, Hijab, Bra, Pants, Socks, Shoes	1.44	0.60	0.092	1.15	0.178	1.56	0.242
	Winter Daraa, Shiala, Bra, Pants, Socks, Shoes	1.43	0.60	0.092	1.17	0.181	1.58	0.245
	Winter Daraa, Shiala, Long trouser, Bra, Pants, Socks, Shoes	1.44	0.60	0.092	1.34	0.208	1.75	0.272
Winter Clothing — Without Shiala	Winter Daraa, Long trousers, Bra, Pants, Socks, Shoes	1.39	0.60	0.092	1.17	0.186	1.59	0.247
Summer Clothing — Without Hijab	Summer Daraa, Bra, Pants, Sandals	1.41	0.60	0.092	0.77	0.119	1.19	0.185
'Traditional' Clothing — Summer	Summer Daraa, Abaya, Shiala, Burqa, Bra, Pants, Sandals	1.79	0.60	0.092	1.38	0.213	1.71	0.265
'Traditional' Clothing — Winter	Winter Daraa, Shiala, Burqa, Bra, Pants, Socks, Shoes	1.55	0.60	0.092	1.01	0.156	1.39	0.216
	Winter Daraa, Abaya, Shiala, Burqa, Long trouser, Bra, Pants, Socks, Shoes	1.94	0.60	0.092	1.80	0.279	2.11	0.327
'Traditional' Clothing — Summer (Without Shiala and Burqa)	Winter Daraa, Abaya, Bra, Pants, Sandals	1.51	0.60	0.092	0.85	0.131	1.24	0.192

D.3 – A standard list of metabolic rates values for various activities, (Source: ASHRAE, 2004: 15)

	Metabolic Rate		
Activity	**Met Units**	**W/m^2**	**(Btu/h ft^2)**
Resting			
Sleeping	0.7	40	(13)
Reclining	0.8	45	(15)
Seated, quiet	1.0	60	(18)
Standing, relaxed	1.2	70	(22)
Walking (on level surface)			
0.9 m/s, 3.2 km/h, 2.0 mph	2.0	115	(37)
1.2 m/s, 4.3 km/h, 2.7 mph	2.6	150	(48)
1.8 m/s, 6.8 km/h, 4.2 mph	3.8	220	(70)
Off ce Activities			
Seated, reading, or writing	1.0	60	(18)
Typing	1.1	65	(20)
Filing, seated	1.2	70	(22)
Filing, standing	1.4	80	(26)
Walking about	1.7	100	(31)
Lifting/packing	2.1	120	(39)
Driving/Flying			
Automobile	1.0-2.0	60-115	(18-37)
Aircraft, routine	1.2	70	(22)
Aircraft, instrument landing	1.8	105	(33)
Aircraft, combat	2.4	140	(44)
Heavy vehicle	3.2	185	(59)
Miscellaneous Occupational Activities			
Cooking	1.6-2.0	95-115	(29-37)
House cleaning	2.0-3.4	115-200	(37-63)
Seated, heavy limb movement	2.2	130	(41)
Machine work			
sawing (table saw)	1.8	105	(33)
light (electrical industry)	2.0-2.4	115-140	(37-44)
heavy	4.0	235	(74)
Handling 50 kg (100 lb) bags	4.0	235	(74)
Pick and shovel work	4.0-4.8	235-280	(74-88)
Miscellaneous Leisure Activities			
Dancing, social	2.4-4.4	140-255	(44-81)
Calisthenics/exercise	3.0-4.0	175-235	(55-74)
Tennis, single	3.6-4.0	210-270	(66-74)
Basketball	5.0-7.6	290-440	(92-140)
Wrestling, competitive	7.0-8.7	410-505	(129-160)